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DISEASES DUE TO PROTOZOAN PARASITES.

TEJERA (E.). **Trypanosomiases animales au Venezuela.** [Animal Trypanosomiases of Venezuela.]—*Bull. Soc. Path. Exot.* 1920. April 14. Vol. 13. No. 4. pp. 297–305.

(A) Equine trypanosomiasis. In Venezuela trypanosomiasis of widespread distribution has been recognised for some considerable time affecting horses and sometimes mules and donkeys. The disease is manifested in two forms, which are clinically different, viz., (a) peste boba, hermosura and tristeza, and (b) desrengadera.

(a) The first form—peste boba—is characterised by wasting, accompanied by oedematous swellings in certain parts, dullness and depression. The disease is insidious in its onset, the first symptom appears to be a rough appearance of the coat and the hair is easily detached leaving bald patches. No other symptom beyond a rise in temperature is noticeable during this stage, but the animal soon afterwards becomes dull and feeds badly; this stage, however, only lasts a short time, sometimes only one or two days. The animal subsequently regains its spirits, its appetite is restored and no sign of disease is noticeable. But, a few hours work again causes the animal to become dull and languid. Later, there occurs an oedematous swelling of the face; the eyelids become swollen and may cover up more or less the eyeball. The swelling extends down towards the breast, and underneath the neck one may fairly commonly see a pendulous swelling of fairly considerable size called by breeders *papera* (goitre). Under the belly a swelling about 2 ft. or more in diameter may be seen around the region of the navel; swelling of the scrotal region is not infrequently seen. Sometimes the swellings disappear and the emaciated condition of the animal, in spite of a normal appetite, may then be more readily noticeable. Symptoms of anaemia are rapidly produced; the nasal and buccal mucous membranes

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become white in colour, conjunctivitis accompanied by persistent lachrymation is not infrequently seen, and a brownish discharge escapes from the nostril. From time to time a rise in temperature is shown. In the last stage the fever is generally continuous and accompanied by dyspnoea and tachycardia. The disease runs its course in one or two months and ends fatally in more than 80 per cent. of the cases.

(b) Desrengadera is characterised by progressive emaciation and very marked anaemia, the animal becomes easily exhausted at work and shows signs of tachycardia and dyspnoea. Very shortly after the appearance of these symptoms troubles are manifested in connection with the nervous system, which consist of inco-ordination in movements, paresis affecting both hind limbs, and more rarely complete paralysis. At the onset the animal is noticed merely to make a false step from time to time. Later flexion is executed with difficulty in the hind limbs and the points of the hoofs are dragged along. The animal walks with its limbs stiff and widely separated. It maintains its equilibrium with greater and greater difficulty and often leans up against some object to maintain an upright posture. Nevertheless the subject may be able to run quite well during this stage. Gradually the symptoms of paresis increase in intensity till the animal is no longer able to keep standing, and finally it remains lying down. If it is given food it may still last a few days. In this form the mortality amounts to almost 100 per cent. In the rare cases which recover paresis affecting the hind quarters persists.

An acute or fulminant form is mentioned in which the animal may die after having shown hardly any symptoms of the disease. The trypanosome causing these outbreaks on the plains of Venezuela was first discovered by Rangel (Rafael) 1906, and this author demonstrated that both clinical forms were caused by the same organism, viz., a trypanosome of the *evansi* type, which measured on an average from 16 to 20μ by 1·7μ. The organism was designated *T. venezuelense* by Mesnil in 1910.

Clinically, the Venezuelan trypanosomiasis is somewhat similar to the Argentine trypanosomiasis known as mal de caderas, although haemoglobinuria is never observed in the former condition whereas it occurs frequently in the latter. The causal organisms are, moreover, morphologically different. *T. venezuelense* appears to be much more highly virulent causing death in from two weeks to two months, while that caused by *T. equinum* generally lasts from two to five months. The Venezuelan disease occurs at the commencement and at the end of the rains, i.e., the majority of cases are seen in March and April. The transmitting agent has not yet been discovered. Tabanids and stomoxyds were examined but no flagellates were found in them. Mosquitoes have been blamed but a sufficient number were not examined. The great plains (*los llanos*) are traversed by innumerable streams which overflow during the rainy season and are converted into lakes during three or four months of the year; this explains the presence of the enormous number of mosquitoes seen.

T. venezuelense shows, naturally, a high degree of virulence for the horse, causing annually the loss of several thousand head. A noteworthy feature about the disease is that it is of very frequent occurrence among animals collected by breeders in kraals, that is, in

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large enclosures surrounded with barbed wire, whilst it is extremely rare in animals living in the wild state. Mules and asses may also become affected with desrengadera, but in a considerably smaller proportion. It is also very common to find on the Venezuelan plains the large rodent known as "chigüire" [or the capybara] (*Hydrocherus capibara*) affected with symptoms of paresis of the hind parts and infected with *T. venezuelense*. RANGEL discovered dogs and monkeys naturally infected with this trypanosome. FERNANDEZ (A. G.) found morphologically identical trypanosomes in the blood of several monkeys (*Mycetes ursinus*) affected with marked emaciation and sometimes paresis of the lower extremity.

The pathogenicity of the trypanosome towards laboratory animals was experimentally tested. Guinea-pigs succumbed in from 20 to 30 days, the incubation period lasting from 5 to 7 days. The parasites increased in number up to within two or three days of the time of death when they disappeared in about 90 per cent. of cases. The trypanosomes assume a very granular appearance. The animals maintain their appetite and show no other symptoms besides fever. The spleen is, as a rule, considerably enlarged. Grey mice died within 15 days after infection, the period of incubation varying from 3 to 7 days. Disappearance of the trypanosomes as was noted in guinea-pigs shortly before death was not observed to take place in mice. In grey rats the disease lasted 15–18 days after an incubation period of 7–9 days. Two rats showed numerous *T. lewisi* in their blood at the time of inoculation. These organisms diminished progressively in number as *T. venezuelense* increased until, after a while, no *T. lewisi* could be found. Before death the rats showed a roughened coat and diarrhoea. Marked swelling of the spleen occurred. A horse was injected subcutaneously with 1 c.c. of blood from an infected guinea-pig; four days later a few scanty trypanosomes were found in its blood and it succumbed in 56 days, after showing numerous trypanosomes in its blood four days before death. At the beginning of the infection the horse presented an irregular temperature rising sometimes to 40·5° C and remaining continuous (about 40° C) for about 10 days before death. The animal maintained its appetite but became extremely emaciated, showed no oedematous swelling but persistent lachrymation. On certain days it was dull and depressed but at other times it was more or less high spirited. Four days before death it commenced to show signs of paresis of the hind quarters and on the day before death it could no longer remain standing. Post-mortem: marked dropsy, haemorrhages on the colon, peritoneal adhesions, liver very much enlarged and affected with fatty degeneration, spleen very greatly enlarged, lemon-coloured liquid in the pericardial sac. Numerous trypanosomes were found in the heart blood.

The trypanosome proved to be very virulent towards the opossum (*Opossum didactylus*). After an incubation period lasting two days the animal died in 22 days. Trypanosomes disappeared from the blood two days before death. The animal became affected with paresis of the hind quarters for a few days before death. Post-mortem the spleen was enlarged. Two monkeys were inoculated, one *Mycetes ursinus* and one *Cebus capucinus*. The first of these died in 19 days and the second in 24 days. A heifer was inoculated

with 1 c.c. of infected guinea-pig blood containing numerous trypanosomes; from the 7th to the 17th day its temperature rose to 40° C. Trypanosomes then became rare in the peripheral blood and four days later disappeared completely. However, its blood proved to be still infective five months after inoculation upon injection into guinea-pigs. No symptom of disease was shown.

(B) Bovine trypanosomiasis. On examining the blood of a cow which was thought to be affected with piroplasmosis the author discovered a trypanosome which appeared to be quite different from *T. theileri*. The parasites were very scanty (scarcely six per film), they agitated the red corpuscles, but did not traverse the field of the microscope. After staining with Giemsa the cytoplasm stained pinkish violet, the nucleus and centrosome stood out quite distinctly; the body was fairly straight, the nucleus oval and situated in the central portion of the body; centrosome deeply stained and situated very near to or actually at the posterior extremity; flagellum started from the centrosome and the free portion was generally from 5-6μ long. The undulating membrane was scarcely visible. Total length including flagellum 16–23μ, width 1·5μ.

The trypanosomes were never numerous in the blood but it is remarked that only two infected animals were examined, and for a short period only. The animals were extremely emaciated. The skin showed numerous bald patches, the mucous membranes were very pale. There was a very firm swelling situated under the neck, sometimes in the dewlap, called "papera" (goitre) by breeders. The animals were dull and depressed. The appetite remained almost normal. Two guinea-pigs and a cat were inoculated with infected blood, with negative result.

The only previous record of a trypanosome causing death in cattle in South America is that of LEGER and VIENNE [this *Bulletin*, 1919, Vol. 7, No. 3, p. 123], and it is quite probable that the trypanosome studied by them was identical with that discovered by the author in view of the fact that the cattle of French Guiana are imported from Venezuela. This trypanosome (named *T. guyanense*), although it was considered to be of the *evansi* type, was not thought to be *T. equinum*, *hippicum*, or *evansi* inasmuch as these are all very virulent towards laboratory animals. Tejera expresses agreement with the authors upon this point and further believes that it is not identical with *T. venezuelense*, which is transmissible to all mammals and sets up a fatal disease. Tejera is inclined rather to agree with MESNIL who believes that *T. guyanense* is simply a variety of, if not identical with, *T. cazalboui* (*vivax*), inasmuch as both parasites are infective towards the ruminants and equidae only, and not towards rats, mice, guinea-pigs, dogs, cats, and monkeys.

[It must be noted, however, that Tejera states that his bovine trypanosome did not cross the field of the microscope in fresh preparations whereas the most marked feature of trypanosomes of the *cazalboui-vivax* group is their intense motility in a translatory direction.—ED.] There is reason to believe that the bovine trypanosomiasis has not long been in existence in Venezuela and the author therefore suggests the possibility that *T. cazalboui*, the causal agent of Souma has been introduced with the importation of hump-backed cattle (zebus) during the last few years.

Cross (H. E.). **A Note on the Treatment of Surra in Camels by Intravenous Injections of Tartar Emetic.**—*Agric. Res. Inst., Pusa. Bull. No. 95.* 1920. 4 pp. 1920. Calcutta: Supt. Govt. Ptg., India. (Price As.2.)

Working in conjunction with Pool (W. A.) from 1917 to 1919 Cross carried out some experiments on the treatment of six camels suffering from surra, with tartar emetic.

Camel No. 1. Aged 8 years. Condition poor. Received daily for six consecutive days 200 c.c. of a 1 per cent. solution intravenously, fed well during treatment, but after the last dose it lost its appetite and did not feed normally for two days. The camel never did well and died 129 days after the end of the treatment, but no trypanosomes re-appeared in the blood.

Camel No. 2. Aged 9 years. Condition poor. Received 600 c.c. of a 1 per cent. solution intravenously for seven consecutive days, off feed at commencement of treatment, but appetite improved and was feeding well on the 7th day. The animal continued to feed well but never improved in condition. It died as the result of an injury to its leg; no trypanosomes re-appeared in the blood up to the time of death since the end of the treatment 179 days previously.

Camel No. 3. Aged 7 years. Condition poor. Received 250 c.c. of a 1 per cent. solution intravenously for three consecutive days, fed well, but on the 4th day it lost its appetite and did not feed well again for four days. Subsequently its appetite was good and it improved greatly in condition. Nineteen months after the treatment the camel was put to work and carried a load of 5 maunds on an average 19 miles a day for 3½ months. 241 days after the treatment one guinea-pig and one rabbit were inoculated with blood from the camel but they remained healthy. The camel died as the result of an accident and no trypanosomes re-appeared in its blood since treatment finished 780 days previously.

Camel No. 4. Aged 7 years. Condition fair. Injected with 200 c.c. of a 1 per cent. solution daily for the first two days and 250 c.c. daily for the next four days. Fed well except on the last day when it fed fairly. For three days after the last dose the appetite was not good but after this the camel fed well and improved in condition. 238 days after the treatment one guinea-pig and one rabbit were inoculated with blood but they remained healthy. The camel died as the result of a castration operation, but no trypanosomes re-appeared in its blood since the end of the treatment 513 days previously.

Camel No. 5. Aged 9 years. Condition poor. Injected with 200 c.c. of a 1 per cent. solution of tartar emetic and subsequently on nine occasions with 250 c.c. on alternate days. Fed well except during the last five days of treatment, when its appetite was fair; again for five days after the last dose the appetite was only fair, but after this the camel fed well and improved in condition. 235 days after the end of the treatment one guinea-pig and one rabbit were inoculated with blood, but remained healthy. About 18 months after the treatment the camel was put to work daily for 3½ months carrying a load of 5 maunds on an average 19 miles a day. Trypanosomes were not detected in the blood on examination 887 days after the treatment, and at that time the general condition was good.

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Camel No. 6. Aged 8 years. Condition fair. Received doses of 60 c.c. of a 1 per cent. solution on 10 alternate days. Fed well during the whole of the treatment. 289 days subsequently one guinea-pig and one rabbit were inoculated with blood from the camel and remained healthy. Twenty months after the end of the treatment the animal was put to work continuously in the same manner as camels Nos. 3 and 5 and for the same period. Trypanosomes were not found in the blood on examination 945 days after treatment, and the general condition at that time was good.

It is concluded that camels Nos. 3–6 were cured, and that therefore tartar emetic gives promise of success in the treatment of surra. It is admitted, however, that before the drug can be definitely stated to be a cure for surra a large number of animals must be submitted to treatment. Dealing with the accidents that may occur during treatment the author mentions that great care has to be taken to inject the drug directly into the vein, otherwise if any escapes subcutaneously sloughing results. Injection of the drug is liable to cause fainting and it must be injected slowly at blood heat. It was found that fainting was not so liable to occur if the injection were given during the intervals between the paroxysms, i.e., when the temperature is not high. Large doses, amounting to 600 c.c. of a 1 per cent. solution could be administered safely in one day to full grown camels if the amount were given in three injections with 2–3 hours interval between the injections. If, on the other hand, this quantity is given in one injection death results in the majority of cases.

Fiske (W. F). **Investigations into the Bionomics of** *Glossina palpalis.* —*Bull. Entom. Res.* 1920. May. Vol. 10. No. 4. pp. 347–463. With 11 figs.*

These studies were made on the shores and islands of Lake Victoria Nyanza, extending over a period of two years, the object being to fix the factors in the "control" of the species which operate in nature and which may be simulated artificially.

It was at first noticed that of flies caught, in most cases the great majority were males, leading one to suppose that the rule is that males are generally in excess. More females were found where the predilection "food hosts" were scanty, and by driving away all such from a small islet and again catching flies, it was found that the sexes were approximately equal—the reason being that males, whether hungry or not, are always active, whereas females are quiescent and not easily caught except when hungry. Sheltering vegetation is a great factor in sex proportion. When food is plentiful, males are to be found in attractively sheltered regions with few or no females. When food is scarce however females are plentiful—not near shelter, but in localities where their favourite reptilian hosts are to be found.

The habits of both sexes are relatively constant. Both have to seek food, and when their hunger is satisfied they seek shelter. The females retire to *massive* shelter, while the males loiter about in moderate shelter, near the open in places where females are likely to pass. Every week or ten days the female repairs to the breeding ground to deposit a larva. "Following swarms" are seen following

* Abstracted by Mr. S. C. J. Bennett, M.R.C.V.S.

almost any moving animal, even those whose blood the flies do not relish, their food hosts in order of predilection being: (1) Crocodile, (2) Varanus (lizard), (3) Hippopotamus, (4) Various antelope and pig, (5) Other wild animals, (6) Domestic animals, (7) Man.

It is thus evident that man is not greatly worried if other hosts are numerous, and also that driving away the main hosts will not improve matters for man, but rather make them worse. These facts were proved statistically. Complete animal depopulation of any isolated island will reduce fly as they will not migrate over any stretch of water more than about 300–500 yards.

Breeding grounds were extensively studied. As the egg reaches the larval stage before being deposited, very few prospective pupae are produced—*less than 4 per month per female*—and these receive great care. They must be deposited away from destructive factors, animal or climatic. The best position is in *dry* sandy or gravelly stretches such as the beach of the lake, but in any case sufficiently shaded from the sun either by large stones or such light vegetation as would grow on this soil. Finely comminuted, *dry* vegetable debris if shaded is very often selected. It is necessary for survival of the species that sufficient food, sufficient *massive* shelter for quiescent females, and suitable dry shady breeding ground be present in appreciable proximity, and it was noticed that fly was most dense where these factors were associated.

There are various inimical factors in Glossina bionomics, affecting mainly the puparium. Sunlight on the soil where they are deposited is fatal and in any but *dry* soil they are subject to predations on the part of various ants, beetles, etc. The breeding ground is instinctively chosen to be free from not only a few but *all* inimical factors; so much so that it is of little value to consider them, a consideration of the specific beneficial factors being more remunerative of information. Adult flies may be destroyed to a degree by spiders or larger flies (dragon flies) and if exposed to direct sunlight for any length of time. The former is negligible and the latter is avoided in that the flies seek shelter. Floods will of course destroy the pupae in the breeding ground but they are rarely placed where a flood is likely to occur. Lack of water, or distance from it, is not inimical to tsetse as they are constantly found inland. However the main food hosts are amphibian by nature, and the most suitable breeding grounds are the beaches. Consequently one expects and actually does find a greater density of fly near water.

Normally flies die off either of "old age" or in consequence of "dispersion" which occurs owing to their getting too far from shelter whilst in search of food. Thus three requisites are indispensable to fly: (*a*) Food; (*b*) Massive shelter for adults; (*c*) Breeding grounds, and a level is maintained dependant on the one most poorly represented.

VON BASSEWITZ (E.). **A Sanguesuga "*Haementeria Offic.*" Transmissora da Pyroplasmose** [Trypanosomiasis ?] **equina sul-americana "Mal de Cadeiras."** [The Medicinal Leech as Transmitter of the South American Equine Trypanosomiasis, Mal de Caderas.]—*Brazil-Medico.*, 1920. May 1. Vol. 34. No. 18. pp. 283–285.

All the equines in the South American Continent are the progeny of imported animals. Mal de caderas is limited in this Continent to

certain, often very small, enzootic centres, containing stagnant water and shallow lakes. It is well known that a certain indigenous large rodent the capybara (*Hydrochoerus capibara*) becomes the victim of periodical outbreaks caused by a trypanosome indistinguishable from *T. equinum*, the cause of mal de caderas. It seems to be a common belief among the native population that outbreaks of mortality among these rodents is an indication of an impending inevitable recrudescence of the equine affection in the same region. This rodent is therefore in all probability the reservoir of the virus and it remains to be proved in what manner the virus becomes transmitted to equines.

It is well known that the disease can be prevented from spreading from infected animals to healthy ones in separate enclosures by means of a simple wire fence. Recrudescences of the disease are also known to occur after a prolonged period of heavy rain. It was noted by KEMMERICH that the disease could be eradicated from large tracts of land in Argentina by simply draining infested pastures. This author also noted on several occasions that horses affected with the disease could be allowed to run at liberty with healthy horses without running any risk of transmitting the affection, even although blood-sucking insects, both diurnal and nocturnal, were present in considerable numbers.

While engaged upon a study of Brazilian leeches von Bassewitz claims to have discovered the actual method of transmission. A foal was bruised severely in one of its limbs and a few of the common medicinal leeches of the vicinity were applied to the inflamed part. Subsequently the animal became affected with an intermittent type of fever and marked wasting, notwithstanding an unimpaired appetite. On examination of its blood the trypanosome of mal de caderas was discovered. The case then evolved as a typical case of the disease with, finally, complete paralysis of the hind quarters, 78 days after the trypanosome had been discovered.

The leeches which had been utilised in this case were preserved and the presence of the parasite in them was verified (19 days after they had been used upon the foal). The caecal sacs attached to the gastro-intestinal tract were full of blood that seemed to have undergone very little change and positive results were obtained in three out of the eight leeches examined. On the following day two rats were inoculated with this material and tubes of NOVY-MACNEAL media were also inoculated. Both the rats rapidly showed numerous trypanosomes in their blood and died in 11 and 14 days, respectively. The culture media also developed numerous clumps of trypanosomes, but these organisms proved to be quite avirulent upon inoculation into an aged donkey. Donkeys are, however, known to be more resistant towards mal de caderas than horses.

[It is regrettable that this author was not able to pursue a more exhaustive series of experiments to establish his contentions.—ED.]

GOODALL (A). **Notes on Thick Film Method of Staining Piroplasms and Anaplasms in Routine Veterinary Diagnostic Work**—*Jl. Comp. Path. & Therap.* 1920. June. Vol. 33. No. 2. pp. 103–105.

A fairly large drop of blood is allowed to fall on the centre of a clean slide, spread out to the size of a threepenny piece or sixpence

with the corner of another slide, and allowed to dry at room temperature protected from dust. An endeavour should be made to make the film of a uniform thickness and not too thick as otherwise coagulation will distort the blood elements. For field work the films can be conveniently prepared in an ordinary slide carton provided with a lid and when dry transported in this carton to the place where they are to be examined.

No fixation is necessary prior to staining; the films are plunged into a bath of the following solution in which they are allowed to remain for 30 minutes: 2 c.c. of a 1 per cent. watery solution of eosin, 4 c.c. of a 1 per cent. solution of azur II, and 220 c.c. distilled water. This solution should be made up fresh every day. The slides should be numbered with a diamond. After staining, the films are washed with distilled water and allowed to dry at room temperature. During the process of staining the haemoglobin is dissolved out and if parasites are present one gets a field of them, which together with leucocytes and a varying quantity of debris is practically all that is seen.

The chromatin and plasma elements of the parasite are said to come out very distinctly with practically the same colouring as is obtained when they are stained intracellularly by Giemsa's method but with the great advantage that one generally obtains a field of several parasites in various stages, which can be studied together without shifting the field.

The method appears to have been used by the author with great advantage in the diagnosis of bovine piroplasmosis, anaplasmosis, East Coast fever and anthrax. It was suggested to him by Gibbs (O. F.), Assistant Bacteriologist to the Public Health Department (Union of South Africa), who employed it in the routine diagnosis of malaria in the human subject.

Aragão (Henrique de Beaurepaire). **Breves consideracões sobre a babesiose e a anaplasmose bovinas.** [Brief Notes on Babesiasis (Redwater) and Anaplasmosis in Cattle.]—*Brazil Medico.* 1919. Jan. 11. Vol 33. No. 2. pp. 9–10.

In this short paper Aragão (of the Instituto Oswaldo Cruz, Rio de Janeiro) discusses some interesting points in connection with the above diseases, and in particular the apparent absence of the parasites from the peripheral blood so commonly observed in cattle suffering from babesiasis, while they can be made easily demonstrable in smears from the internal organs. This affinity for the internal organs is manifested by several closely related species of Haemosporidia belonging to the families Haemogregarinidae, Leucocytozoidae, Haemoproteidae, and Plasmodidae, so that the parasites might be actually denominated Splanchnozoa and this peculiar affinity Splanchnotaxia. He again discusses the vexed question as to the specificity of the anaplasms and cites work done by himself and Dias, and since claimed to have been confirmed by many other authors, repudiating the parasitic nature of these bodies, which they claim to have found in all groups of animals from man to marsupials and to be in reality degeneration forms within the red corpuscles.

The absence of Babesia parasites in the peripheral blood does not preclude their absence from the entire body, inasmuch as very

frequently in these cases the parasites are collected in large numbers in the internal organs.

Sometimes the piroplasms exhibit a marked predilection for the internal organs, in the same manner as is known with regard to certain closely allied Haemosporidia, which are localized and pass important phases of their development in these parts, sometimes within and sometimes outside the red corpuscles.

This very characteristic property of these parasites might be given the name organotaxia. The anaplasms are minute bodies of a haemic, and not parasitic, nature, and bear absolutely no relationship to the babesiae.

FISCHER (Walther) & SCHEIDEMANN (Hans). **Klinisches und Histologisches ueber Hunde-Babesiose.** [Canine Babesiasis: A Clinical and Histological Study.]—*Cent. f. Bakt.* 1. Abt. Orig. 1920. Jan. 10. Vol. 84. No. 1. pp. 35–43.

In 1915 the sporting dogs kept by German prisoners in their internment camp at Nanking, China, succumbed rapidly after severe jaundice. On post-mortem examination the animals were found to be severely infested with *Schistosomum japonicum*, which is very widespread in the country, and the intense jaundice would appear to be due to these parasites and their eggs. In the following year a disease showing similar symptoms, that is, of suddenly occurring haemoglobinuria and jaundice and rapid death was observed among the sporting dogs. In the first of these cases, however, no schistosomum infection was discoverable, and on blood examination piroplasms (*Babesia canis*) were found in the red corpuscles. The diagnosis made in the preceding year was probably therefore erroneous. Forty dogs succumbed to the disease in the summer of 1916. A careful examination was made of three cases that had succumbed after the acute form of the disease, and of four that developed a chronic form and recovered.

According to NEUMANN-MAYER the clinical course of canine piroplasmosis is of short duration. It develops with symptoms of profound anaemia accompanied with fever, jaundice, and haemoglobinuria, and may in a few days end fatally after rapid wasting. In the chronic form haemoglobinuria is often absent, the principal symptoms being wasting and severe anaemia. The symptoms observed in the authors' cases were of much the same order.

After a short preliminary stage characterised by dullness and depression, lasting from 1 to 2 days, the animals became affected with rapid loss of condition so that a dog in good condition might waste in two or three days to a skeleton. Simultaneously, signs of severe anaemia were manifested, the eyes became sunken and developed a characteristic lustre, there was a high fever reaching 40–41° C, haemoglobinuria was seen early in the disease, respiration was markedly accelerated; the loss of condition was such that the dogs could not remain standing after a few days, the sensory organs were markedly affected, and one or two days prior to death a marked jaundiced discolouration of the skin and mucous membranes was seen. According to SCHILLING acute cases terminate in death in from 4 to 10 days. In the cases observed in Nanking the course of the disease was more prolonged, 10–14 days. The temperature was never observed to return to normal just before

death. The sudden appearance of jaundice just before death was also a typical feature in the authors' cases. In the chronic cases there was no decided difference in the symptomatology, except that some of the symptoms were absent, or less severe than in the acute cases. The preliminary stage appeared to last somewhat longer; wasting took place just as rapidly and was just as striking, but the appetite did not disappear completely and the sensory organs were not so markedly affected. Anaemia was sometimes extraordinarily advanced. The disease attained its maximum intensity in 3 to 5 weeks, and at this time the loss of condition was such that the affected animal could hardly stand. Recovery then took place very slowly, the haemoglobinuria gradually disappeared, the anaemia became less and less distinct and in 2 to 3 months the subject usually completely recovered. In one case the disease only lasted six weeks. In spite of a good appetite this animal failed to lay on a normal amount of fat. Jaundice was observed in two of the chronic cases that ended in recovery.

Besides the decrease in the red corpuscles the increase in the white corpuscles was very marked, reaching 54,000 per c.mm. Nucleated corpuscles were seen and the increase in white cells did not affect the polynuclear leucocytes but was rather due to an enormous quantity of myelocytes and also of large lymphocytes (the so-called transition cells).

The post-mortem changes were as follows:

Marked pulmonary oedema was observed in no cases and only once was a small broncho-pneumonic centre discovered. The striking dilatation of the lung capillaries was characteristic (a point which had also been commented upon by NOCARD and KINOSRITA), as also was the frequent discovery of bone marrow cells (megakaryocytes), either unchanged or with pyknotic nuclei. A further characteristic was the presence of very small or minute hyaline thrombi which seemed to be present in association with the bone marrow cells.

In the kidneys the changes typical of haemoglobinuria were observable, viz., haemoglobin in the lumen of the tubules and solid haemoglobin in the pelvis. Further changes of the renal epithelium were sometimes observable such as parenchymatous nephritis together with the presence of hyaline, epithelial, albuminous, and cylindrical casts. In most of the authors' cases, however, there was no appreciable nephritis. There were very striking changes in the liver, comprising invariably intense bile congestion in its substance; characteristic small necrosed areas were always found in the centre of the lobules; very marked capillary dilatation. In these capillaries there were often very large quantities of bone marrow cells. In some places a peri-vascular infiltration with blood corpuscles could be seen. A round-celled infiltration in the peritoneal covering of the liver was only observed once.

The characteristic change in the spleen was the enormous swelling of the tissue spaces, which were filled with blood cells, pulp cells, and probably also with some other cells. The presence of numerous bone marrow cells and the tendency towards the formation of small thrombi was also characteristic. This was associated with the formation of infarcts which seemed in most cases to be formed by the occlusion of numerous very small vessels with hyaline thrombi and not by embolism of the splenic artery.

In the mesenteric lymphatic glands signs of catarrh of the tissue spaces and blood resorption were always observable. In all organs the capillaries were markedly dilated and the blood extraordinary rich in nucleated cells. In the red corpuscles numerous piroplasms were seen. The jaundice did not appear to be purely an obstructive jaundice but was also at least partly haemolytic in origin.

The piroplasms conformed to the descriptions given of *Babesia canis* except that in some cases they seemed to be exceptionally small. The transmitting tick was principally *Rhipicephalus evertsi*, the red tick; a few specimens of *Rhipicephalus sanguineus*, the transmitter of canine piroplasmosis in India were also seen. The existence of piroplasmosis as the cause of this disease does not appear to have been suspected by the local veterinary surgeons, who attribute it chiefly to filarial infestation.

SMITH (Ernest I.). **Tick Eradication in the South.**—*Jl. American Vet. Med. Assoc.* 1920. July. Vol. 57. (New Series. Vol. 10.) No. 4. pp. 423–429.

The subject of tick eradication has received the closest attention from the United States Bureau of Animal Industry and the various State Livestock Sanitary Boards since about the year 1905. Before that year serious losses occurred among cattle in numerous places below the Quarantine Line and also in cattle conveyed across the Line into the area known to be free of ticks. Therefore, in order to preserve fully the cattle industry in the Southern States it became necessary for the Federal and State authorities to join forces in educating the cattle owners of the South. The fundamental principle in the eradication was to secure the co-operation of the masses; hence it was necessary in the first place to organise a general campaign of education, and notably to convince the people of the damage caused by the tick, and in order that the losses might cease to devise a practicable method whereby the tick might be completely eradicated. Curative measures were out of the question. The tick question was lucidly and concisely explained by MOHLER (J. R.) in 1905 in a *Bulletin* (No. 78) entitled "Texas Fever, with Methods for its Prevention." It was explained that the tick had probably been brought into the United States with the importation of cattle by the Spaniards during the early colonisation of Mexico. It can readily be seen how it gained such a tremendous footing in the South because the traffic of cattle across the Rio Grande, from Mexico into Texas, was more or less continuous. The tick was probably introduced into the States half a century ago and during the years that have elapsed its spread throughout the Southern States has been an easy matter.

In 1905 the Quarantine Line passed through about the lower third of Virginia, the extreme western end of N. Carolina, zig-zagging midway through Tennessee, with an upshot into Kentucky where three or four Counties were included; thence across the boundary line between Arkansas and Missouri; a part of Oklahoma; then diagonally in a south-western direction across the western end of Oklahoma through north-west Texas to the Rio Grande River, just south of New Mexico, where it followed the Boundary Line between New Mexico and Arizona along the lower third of the eastern line of California; thence in an

irregular manner across the State about half way up ; thence across to the Pacific Ocean. Briefly, this included over half of California, three-fourths of Texas and Oklahoma, all of Arkansas, Louisiana, Mississippi, Alabama, Georgia, and South Carolina, half of Tennessee, a small portion of Kentucky, about seven-eighths of North Carolina, and half of Virginia.

The only methods then available for the eradication of the ticks were to employ the use of pasture rotation, on large ranches dipping the cattle in Beaumont oil, gathering them up in a corral, rubbing them once or twice with a greasy rag, or in cases where practicable hand-picking them.

In 1906 *Farmers' Bulletin* (No. 261), written by MAYER (August), was issued by the United States Department of Agriculture. MAYER pointed out that the advent of the Mexican boll weevil would force the Southern agriculturist to give first consideration to the cattle industry of the country. The presence of the tick was stated to be the sole reason why the South was not a cattle country. MAYER was a resident cattle raiser in the heart of the tick territory, where the parasite continued to multiply until late in the autumn, and again commenced its activities early the following February. All cattle were heavily infested with the exception of a very few pure bred herds. A few owners had their cattle immunised against Texas fever by the subcutaneous injection of blood from a tick-infected native animal ; this did reduce the losses among the imported non-immune cattle to about 8 per cent. It, however, was recognised to be an inadequate measure. MAYER's main idea appeared to be the complete destruction of the cattle tick. A few years later the Bureau of Animal Industry commenced to establish a few offices in the Southern States in co-operation with the Livestock Sanitary Boards for the purpose of gaining more information relative to the eradication of the tick. A stupendous amount of opposition, resulting largely from indifference, ignorance, and prejudice, on the part of owners, had to be overcome by the veterinary inspectors, but before very long their persistence in carrying out their educational propaganda was rewarded.

Before dipping vats came into general use the States of Tennessee and Kentucky, and probably also California, succeeded in getting most of their tick-infested areas released from quarantine. These preliminary results paved the way for the general construction of dipping vats involving the use of arsenical solution, which has since become so popular. An interesting point in this connection was that when a county decided to carry out tick eradication the adjacent counties soon became caught up with the same spirit and thus when the work assumed large proportions in any one State the effects were quickly felt in the adjacent States. As time progressed a considerable amount of money had of necessity been expended on these operations and millions of cattle had in consequence lost their immunity. The counties which had been released from quarantine therefore commenced to demand State protection and insisted that every county should provide means for the complete eradication of the tick. By this time the majority of people were thoroughly cognisant of the fact that tick eradication was a success and that it was an investment instead of an expenditure. People at large then suddenly realised that something drastic must be done in order to

protect the cattle that had lost their immunity. A number of pedigree herds had been established and cattle owners were endeavouring to obtain better stock to improve the best class of native cattle. In view of these circumstances the various State authorities had of necessity to take the matter in hand.

The first great commonwealth to pass a State-wide law was Mississippi, followed owing to the progress of public opinion by Louisiana, Texas, Alabama, and Georgia. Experience shows that the so-called State-wide law governing the work of tick eradication is the only solution of the problem, inasmuch as it gives an equal distribution of funds, brings about uniformity of the law, and above all, adds a greater dignity to the work by recognising it as compulsory on the statute books of the State.

At the present time much of the area that was originally quarantined has been released and it would appear that within five years the tick will be completely exterminated. It is even hinted that some scientific institutions are commencing to collect samples of ticks to preserve for future study. It is felt that the present methods are nearly perfect, and there would be some hesitation about making a drastic change. Up to December 1st, 1918, 63 per cent. of the territory originally quarantined had been released. This result has been only brought about by the close co-operation of press officials and of the various administrative and judicial authorities.

In some counties where the proper results have not been obtained in spite of the expenditure of a considerable amount of money the situation on analysis shows that every body of officials had fulfilled their obligations with the exception of the court officials. Such a delinquency has been particularly in evidence in Louisiana.

In 1919 the number of square miles under quarantine was 348,133. During the year the Bureau furnished 319, the States 533, and the Counties 1,850 men for the prosecution of this work. The total approximate cost to the Bureau was 655,078·04 dollars, to the States 499,003·80 dollars, and to the Counties 2,428,901·15 dollars. The total approximate quantity of proprietary cattle dip used by the various States in 1919 was 250,196 gallons. Some of the States used crude chemicals and some of the Counties in the various States did likewise. The amount of arsenic used during the year was 903,553 lbs. The total number of cattle dippings in 1919 up to November 1st was 48,530,229, including 311,014 dippings of horses and mules. The number of vats in operation was 35,534. It was anticipated that by December 1st 1919 there would be available for release from quarantine in the Southern States 47,301 square miles, which would leave still under quarantine 220,426 square miles. It was reported that during 1919 approximately 19,170 pedigree or high-class grade cattle for milk producing were imported into nine of the States. In addition there were imported 220,863 head of pedigree or high class grade cattle for beef production. The number of cattle had increased in nearly all the States, in one State 500 per cent. from 1908–1912. The average increase in the intrinsic value of the cattle since tick eradication was inaugurated was estimated at from 20 to 100 per cent. and in addition the land value had increased from 25 to 100 per cent.

FACER (A. W.). **Hints on Dips and Dip-Testing.**—*Rhodesia Agric. Jl.* 1920. June. Vol. 17. No. 3. pp. 255–261.

In this paper the author gives some particulars with regard to the working of the " Champion Dip-Testing Apparatus " produced by the Standard Arsenic Company, Salisbury, Southern Rhodesia. The object of this apparatus is to enable the farmer to test his dip on the spot instead of having to forward it, often from a considerable distance, to an agricultural chemist.

The sample to be tested is taken in a clean dry bottle of about 1 pint capacity after the tank fluid has been thoroughly stirred (preferably by passing cattle through it) and is tested as soon as possible. Recent research has proved that the effective and safe solutions for dipping at the different intervals are 0·08 per cent. arsenious oxide for three-day, 0·16 per cent. for seven-day, and 0·24 per cent. for fourteen-day dipping. From the dip mixers' and dip testers' point of view all the cattle dips on the (Rhodesian) market, whether liquid preparations such as " Champion Dip " and liquid arsenite, Cooper's, or Arsenoda, or solid arsenite of soda, are essentially the same ; they contain large amounts of arsenious oxide rendered soluble by combination with soda. Substances such as tar products and aloes which are added to the dips to impart odour, taste, adhesiveness, or greater wetting power to the diluted fluid do not concern the tester whose aim is to find the strength of the fluid in terms of arsenious oxide per cent.

Arsenious oxide possesses the property of absorbing iodine in a certain definite proportion (2 ozs. of arsenious oxide absorb about 5 ozs. of iodine). As the soda in dips would interfere with the reaction it is removed by adding sulphuric acid (acid solution A in Champion outfit), from 20 to 30 drops per bottle of dip being usually sufficient. When sufficient acid has been added, the dirt and slime usually settle as a curd-like sediment enabling one to pour off a clear liquid, after allowing the bottle to stand for a short time. The clear fluid is now poured off into a measuring cylinder ; if it does not clarify after the addition of acid in reasonable quantity (up to about 40 drops per whisky bottle) it should be filtered. Exactly 50 c.c. are then measured out and put in the small beaker provided. The excess of acid in the fluid, which would interfere with the test, is neutralised by adding bicarbonate of soda (alkali D of testing outfit) until there is no further effervescence. A little of the common adhesive paste known as " gloy " is then added, which contains dissolved starch—this gives a blue colour with the slightest trace of free iodine. The iodine testing solution is then gradually run in from a burette, the liquid in the beaker being thoroughly and constantly shaken during the process, and when a decided blue colour appears and persists the number of c.c. of the iodine solution absorbed is read off on the burette. The strengths of the solutions employed are such that when this figure is divided by 100 the amount per cent. of arsenious oxide in the dip is obtained (e.g., 12·5 c.c. of iodine solution correspond to 0·125 per cent. arsenious oxide). The strength of the dip in the terms of any of the recognised dip materials can now be found by

reference to the tables in the Champion booklet. The regulation strengths for dipping at different intervals are as follows:

		3 day.	7 day.	14 day.
Arsenious oxide		·08 %	·16 %	·24 %
		galls. water	galls. water	galls. water
Cooper's dip	1 gal. in	312	156	104
Arsenoda dip	1 „ „	700	350	233
St. O'Gorman dip ..	1 „ „	600	300	200
Champion dip	1 „ „	600	300	200
Champion liquid arsenite of soda dip	1 „ „	800	400	266
Solid arsenite of soda dip (80 per cent.)	1 lb. „	100	50	33

If a dip is much stronger or weaker than the desired strength for that dip at the given dipping interval its strength must be corrected and precise details are given in the tables found in the Champion booklet as to how the error can be rectified. A few typical problems are worked out in order to elucidate this matter. Under certain circumstances arsenious oxide in the arsenite dips tends to change into another form producing arsenate. As arsenate it cannot be estimated by the ordinary field tester. Arsenate has only about half the tick destroying power of arsenite and at the same time it has a poisonous and scalding effect upon cattle. When a tank is in frequent use the amount of arsenate present is usually so small as to be practically negligible, but if a tank is allowed to stand for some time without use there is a tendency for the proportion of arsenate to increase. In these circumstances it is better that a complete analysis should be performed by the Agricultural Chemist. Arsenite changes into arsenate fairly rapidly when dip is allowed to stand in a bottle but this is easily prevented by adding to the bottle about 15 to 20 drops of sulphuric acid.

MORGAN (Edw.). **Interesante para los Criadores. Desinfeccion de ganados y sus efectos.** [Dipping and its **Effects.**]—*El Universal*, Caracas, Venezuela. 1920. June 10.

A cutting from the above newspaper has been received from its author and its translation together with an intimation that there "is nothing in it, except the old (tick) story repeated, but it will give an idea about the state of affairs in a South American Republic like Venezuela." So much is the author impressed with the importance of his subject that he states " it is almost as essential as it is to feed animals to dip them in an efficient standardised dip at regular intervals, and especially is this the case in tropical countries, where ticks and other parasites are a pest to animals which suffer so much from other skin diseases such as mange, etc."

The measures taken to combat or eradicate ticks in other countries are mentioned; the harm done to stock owing to the absorption of blood by large numbers of ticks and infestation of the wounds caused subsequently by maggots, as well as the diseases transmitted by their

agency are also dealt with. Redwater (tristeza) is of great importance in Venezuela. The necessity for dipping at regular intervals is explained; the dip recommended is Cooper's dip, which is made up by mixing with cold water, and not with hot water as used to be the case, and thus the necessity for lighting fires in the open is eliminated. The cost of eradicating the tick is estimated at only about 2*s.* 6*d.* per head of cattle. Cows are calculated to yield at least one quart more milk daily when freed from ticks and other parasites. An average Venezuelan bullock regularly dipped will increase in weight from 10 to 15 per cent. more than another, infested, animal. So far as Venezuela is concerned nothing appears to have been done in the way of dipping. The worst infected areas by far are the fattening corrals (potreros) in the country. This is probably attributable to the crowding together of the cattle. Burning the potreros seems to be one easy way of getting rid of the pests but it would also have the effect of destroying many of the finest or more delicate grasses which do not root deep in the soil. Cattle should not be dipped during the course of a journey but should rest a day or two at the end of the journey before being immersed in the arsenical bath. All cattle should be dipped before entering the fattening potreros, especially if a system of dipping to eradicate ticks is adopted. There should be a convenient quarantine potrero to hold infested animals before they are allowed to enter into the fattening potreros.

HASSELMANN (Gustavo). **Sobre a sarcosporideose bovina no Districto Federal. (2. Nota previa.)** [Bovine Sarcosporidiosis in the Federal District, Brazil.]—*Brazil Medico*, 1919. Oct. 11. Vol. 33. No. 41. pp. 321–322.

The author, who is attached to the Instituto Oswaldo Cruz, Rio de Janeiro, commenced studies upon the structure of the myocardium in various mammals in 1915. He was then struck with the frequency with which sarcosporidia was encountered in the heart muscle of the ox. A careful laboratory examination would appear to demonstrate the parasites in 100 per cent. of cases. The parasite is identified with *Sarcocystis tenella* Railliet. The cysts, which were always found in the interior of the muscle fibres, were of an elongated elliptical or fusiform shape, 470μ long by 75μ in maximum breadth. The number of parasites in a preparation varied; the largest number was 8 per microscopic field (ocular 2, objective A Zeiss). The cysts were bounded externally by a thin structureless membrane and the interior was divided into spherical masses with regular margins, and in the interior of these masses were situated the spores which were cylindro-conical in shape and somewhat curved on both sides and their narrower extremity terminated in an elongated or blunted point. In the posterior part of the spore there were noted a nucleus and small refractile granules which seemed to be more abundant in front of the nucleus. Anteriorly the cytoplasm was dense, homogeneous and devoid of transverse oblique striations, but in living specimens a single refractile longitudinal striation was seen disposed along the middle line. The spore measured 14–17μ by 4–6μ. No lesion was caused by the presence of the parasite in the muscle fibre.

TYZZER (Ernest Edward). **The Flagellate Character and Reclassification of the Parasite producing "Black Head" in Turkeys—*Histomonas* (Gen. Nov.) *meleagridis* (Smith).**—*Jl. of Parasitology.* 1920. Mar. Vol. 6. No. 3. pp. 124–131. With 1 plate.

Reference has already been made in this *Bulletin* [1919. Vol 7. No. 4. p. 194] to this author's studies upon the parasite of blackhead in turkeys. In this article he further describes the morphological characteristics of the organisms, and the points upon which his classification are based are summarised as follows:—

"*Classification.* Smith originally placed the parasite of Blackhead, on account of its amoeba-like characteristics, tentatively in the genus *Amoeba*, and much later (Smith, 1915) retained the same generic name under a different spelling *Ameba*. The view expressed by Hadley that this organism is identical with a previously described coccidium, *Eimeria avium*, is untenable, and was later abandoned by this author. Doflein's suggestion that the organism as a parasitic amoeba should be included in the genus *Entamoeba* now fails to apply with the discovery of flagellate characteristics. Both Jowett's (1911) and Hadley's (1916–17) incorporation of the parasite into the genus *Trichomonas* appears to be based upon a confusion of at least two intermingled species for a single species and is unacceptable without more conclusive evidence.

"The proof that this organism is not an amoeba makes necessary its reclassification. Its trichomonad affinities are indicated by the type of nuclear division which it presents, by the number of flagella indicated in the five lines radiating from the blepharoplast and by the character of its pulsating movements which appear under certain conditions so that it may thus be included in the family *Tetramitidae*, Saville Kent, 1880, as modified by Chalmers and Pekkola, 1918. The assumption of amoeba-like characters with respect to both movement and ingestion of solid particles together with its ability to invade vertebrate tissues appear to justify the creation of a new genus for this species. In case it should prove to be an aberrant form of a type species already described, the generic name here offered may then be suppressed. The name *Histomonas* is proposed for this genus, which may be defined as follows:

"HISTOMONAS gen. nov. Pleomorphic parasitic Tetramitidae with amoeba-like phases of development within tissues of host. The kinetic structures, associated with blepharoplast, intraprotoplasmic during amoeba-like phase. Nuclear division trichomonad in type with well developed paradesmose.

"Apart from the pulsating forms in hanging drop preparations of material from lesions, flagellated stages are unknown. No contractile vacuole, no cytostome observed.

"Type species:—*Histomonas meleagridis* (Smith, 1895) Tyzzer, 1919.

Syn.—

Amoeba meleagridis Smith 1895.
Entamoeba meleagridis Doflein 1911.
Ameba meleagridis Smith 1915.
Eimeria avium Hadley 1909.
Trichomonas eberthi Jowett 1911.
Trichomonas Hadley 1916"

DISEASES DUE TO METAZOAN PARASITES.

BISHOPP (F. C.). **Thoughts on Insects in Relation to Production of Live Stock and Poultry.**—*Jl. American Vet. Med. Assoc.* 1920. July. Vol. 57. (New Series. Vol. 10.) No. 4. pp. 414–422.

The author first discusses the ways in which insects cause loss to the above industries. A survey of the literature indicates that there

are about 150 different disease-producing organisms which invade the warm-blooded animals including man, in the transmission of which insects are more or less certainly connected, and the number of species of insects concerned with the spread of these diseases is approximately 250. This does not include the several hundred species which cause injury and annoyance by their direct attack upon animals. In the case of many common diseases the etiology and method of spread of which have not been definitely determined insects should be given careful consideration (equine infectious anaemia, swine fever haemorrhagic septicaemia, and anthrax). Insects act as vectors of disease in two principal ways, viz., as mechanical carriers, and as necessary intermediate hosts to the organisms. Insects capable of causing injury by direct attack produce their effects by their blood-sucking habits, by living in the host, by destroying tissue, or by annoyance.

Dealing with the introduction and spread of insect pests into the Southern States the author states that the great majority of them are invaders from foreign lands. Some were evidently introduced at a very early period in the history of the country and there is no definite history as to how they came (e.g., the stable fly, the various species of lice on domestic mammals and fowls, and at least two of the common horse bots). The horn fly, on the other hand, is of comparatively recent introduction, having been brought into the country about 1887. Its dissemination throughout the States, which took place during the next few years, has been rather closely followed and recorded. The horse fly or red-tailed bot fly appears to have been introduced about 1898 and has since spread over Montana, the Dakotas and parts of Nebraska, Iowa, and Minnesota. The native species of insects while fewer in number are no less formidable. The cattle tick is probably an American species, or, at least, a variety which infests the Southern States and is distinct from the forms occurring in South America, South Africa, and elsewhere. The spinose ear tick is another native form and the screw worm is strictly American. The danger of introducing still further dangerous parasites from abroad has to be borne in mind. With those species of ticks which remain on their hosts for long periods transportation is easy, and flies and bots can readily be introduced. Owing to the comparatively short life of the adult insects in the order "Diptera," or flies—the most important insect transmitters—there is less chance of their successful introduction, but several ways in which they may be brought across in present conditions are mentioned.

Dealing with the effects of adverse climatic conditions in preventing the introduction and spread of insects the author states that in pre-quarantine days cases of Texas fever used to occur repeatedly in the Northern States owing to the introduction of the tick from the South with imported cattle. However, the cold and aridity operated to kill out the tick again in the North and much of the West. The so-called European ox warble *Hypoderma bovis* has been introduced rapidly into the South in the bodies of cattle taken across from North-Eastern States, but it appears never to have established itself in the warmer regions of the country.

A limited opportunity for spread is offered by the transportation of animal products. Again the free-flying forms, notably the flies,

may spread by flight, and this method of dissemination while of much less importance than the transportation of infested animals, appears in the light of recent work to be of greater importance than was formerly supposed. In experiments carried out by LAAKE (E. W.) and the author it was determined by releasing and re-capturing marked flies that they travel considerable distances in rather a short time. Screw worm flies were re-captured 15 miles from the point of liberation and the common black blow fly and the house fly 11 and 13 miles respectively, from the point of release. Evidence was also secured which strongly indicated that a number of the common American flies could by successive flights and breeding places spread distances of hundreds of miles.

In permitting the limitation of spread of species to be controlled by natural factors alone there is to be considered the danger of insects adapting themselves to various conditions of life and thus becoming increasingly important as pests. There may at times prevail a set of conditions which are temporarily favourable for the spread of a species.

Examples are given of American insect pests concerning which the enforcement of restrictive regulations has become necessary, viz., the fowl tick, the ear tick, spotted fever tick, tropical fowl mite, nose fly, and pigeon hippoboscid. Three of these are known agencies in the dissemination of disease. The fowl tick, which is one of the most serious pests of poultry in the South-West, is gradually invading new territory although it is believed that it will always remain largely restricted to the semi-arid regions. This species has been proved to be the carrier of spirochaetosis of fowls in South America and other countries, but this disease is not known in the United States. The ear tick, a pest of considerable importance to cattle and other live stock [this *Bulletin* 1919. Vol. 7. No. 4. p. 219] has been introduced into the Northern States of the Rocky Mountain region in the last few years, although it is largely restricted by the same climatic factors as the fowl tick. The nose fly is gradually spreading eastwards and southwards from Montana or South-eastern North Dakota, where it was apparently first introduced, but it is surprising that this important pest of horses has not been widely spread over the country during the last few years when many animals were taken out of the infested territory for military purposes. The spotted fever tick transmits a dangerous disease of man in the northern Rocky Mountain Regions; the question of the scattering of this tick on horses and cattle, which are the principal hosts of the adult, needs serious consideration. Accurate information as to the life history and seasonal occurrence of the various forms of parasites is required in order that control and quarantine work may be effectually carried out.

Restrictions are often proposed which are of doubtful value in preventing the importation of pests and which may be a serious handicap to the industries involved. It is noted that Australia maintains a quarantine on cattle shipped from the United States, Great Britain, and Canada during all seasons except the period between October and May with a view to excluding the ox warble. The facts known with regard to the seasonal occurrence of this pest clearly show that such restrictions would by no means give the desired protection. Within the United States the question has been brought up of eliminating the

danger of spreading the winter or elk tick into various districts. This species is a serious pest of horses and cattle as well as elk in the Northern Rocky Mountain region. It has been determined that this tick is not to be found upon hosts during the summer months ; hence this immediately suggests the possibility of allowing elk or other hosts to travel out of infested territory during the summer.

The author terminates by indicating that the co-operation of a number of agencies is necessary in working out matters appertaining to the relation of insects to animals. For instance, in endeavouring to put into effect proper range sanitation measures one has to face a many-sided problem. Carcase disposal is of the utmost importance in combating certain diseases such as anthrax and blackquarter ; this same practice is also necessary to accomplish the control of the important live stock pest in the South-West known as the screw worm. The author indeed believes that should range sanitation be carried out in a thorough manner the screw worm, which is now annually responsible for losses amounting to millions of dollars, would be rendered of little importance. Material benefit would undoubtedly be gained by the industries concerned if there were co-operation in reporting on the abundance, injury, and spread of injurious species. There is no doubt that many parasites such as the common lice could be much more readily eradicated than the cattle tick, which is now disappearing from the Southern States.

Senevet (G). **Note sur quelques Ixodes parasites des animaux domestiques recueillis à Mytilène de février à juin 1916.** [Ixodes collected on Domesticated Animals at Mitylene (Island on the West Coast of Asia Minor) from February to June 1916.]—*Bull. Soc. Path. Exot.* 1920. Apr. 14. Vol. 13. No. 4. pp. 260-261.

Rhipicephalus sanguineus on the ox, ass, and dog. *R. bursa* on the ox and the goat. *R. simus* on the ox and ass. *Hyalomma syriacum* on the dog and a species of turtle. *H. aegyptium* on the ox.

Hill (Gerald F.). **Relationship of Insects to Parasitic Diseases in Stock. Part. II. Certain Points in the Life History of *Melophagus ovinus*, Linn., the Sheep Louse-fly, or "Sheep-Tick."**—*Proc. Roy. Soc. Victoria.* Vol. 31. (New Series). Pt. I. pp. 77-107.

The life history and habits of the sheep "louse-fly," "tick," or "ked" have been known for many years as the result of investigations carried out in Europe and the United States of America. Prior to 1916 no similar investigations appear to have been carried out in Australia, and as there was no marked difference ascertained in the life-history of the pest legislation for its control by dipping was introduced accordingly. The enforcement of the Sheep Dipping Act, however, did not have the effect of eradicating the pest. Many sheep owners contended that this failure was due to the fact that the keds and their pupae became dislodged from the fleece of the host and remained viable in the grass, brushwood, or elsewhere for a longer or shorter period, where the pupae developed into young keds, and these with similarly dislodged adults subsequently infected ked-free sheep. It thus seemed desirable to obtain further information

with regard to certain points in the life history of the parasite and with this object in view certain experiments were begun by SWEET and SEDDON in 1916, but their work was incomplete [this *Bulletin*. 1917. Vol. 5. No. 3. p. 177].

The author therefore commenced in March 1917 a series of observations and experiments to verify under a variety of conditions the work of SWINGLE in the United States of America and SWEET and SEDDON in Victoria, and also to determine the period of viability of the pupa when removed from the host.

Under the most favourable conditions 100 per cent. of the pupae removed from the host were found capable of developing into young keds. This high percentage of emergences was obtained in one experiment in which the pupae were placed on *moist* sheep-pen sweepings and kept in an incubator at temperatures ranging from 64·4° F. to 82·4° F. The first young ked emerged on the 10th day, others followed until the 26th day, when the last emerged.

The next highest percentage of emergences was obtained in an experiment in which the pupae were placed on *dry sand* in an incubator at a uniform temperature of 71·6° F.; under these conditions 82·6 per cent. pupae developed into keds, the first on the third day and the last on the 32nd day.

The next most favourable condition for the development of the pupae was a temperature of 93·2° F. and the substitution of moist paper for dry sand. Under these conditions 75 per cent. of pupae, less than one day old when gathered from the host, emerged on the 18th and 19th days.

A slightly lower percentage of emergence, viz., 72 per cent. was obtained when the pupae were kept in a covered tin on the laboratory table where the temperature ranged from 60° F. to 90° F.; the first ked emerged on the 1st day and the last on the 42nd day. When the pupae were kept on dry sand in the incubator at a temperature ranging from 64·4 to 82·4° F. 60·6 per cent. developed into the adult stage, the first on the 4th day and the last on the 21st day.

On moist sheep-pen sweepings in an incubator at temperatures ranging from 78·8 to 86·9° F. 57 per cent. of the pupae produced keds, the first of which emerged on the 12th day and the last on the 21st day.

42·8 per cent. of the pupae which were incubated in a dry dish at 91·4 F. produced keds, the first of which emerged on the 7th and the last on the 11th day.

The next most favourable condition for development was in wool on a post out of doors at a season of the year during which the temperature ranged from 47 to 84° F.; 31·5 per cent. of the pupae produced young keds, the first of which emerged on the 3rd day and the last on the 27th day. This result is stated to be of particular interest inasmuch as the conditions under which the experiment was carried out closely simulated natural conditions.

Only a very slightly lower percentage of emergences, viz., 31 per cent. was obtained in an experiment in which the pupae were placed on dry sheep-pen sweepings in an incubator at a temperature of 71·6° F.; the first pupa developed into a young ked on the 4th day and the last on the 23rd day.

In two experiments carried out under almost natural conditions, viz., on sand on the lawn, only 6 per cent. of the pupae developed. In one of the experiments during which the temperature ranged from 44 to 68° F. the first pupa developed into a young ked on the 6th day and the last on the 11th day. In the other experiments during which the temperature ranged from 34 to 86° F. the first ked did not appear until the 22nd day, and the last not until the 34th day.

The experiment which gave the lowest percentage of emergences was one in which the pupae were placed on dry sand and incubated at a temperature of 96·8° F. Under these conditions 4 per cent. of the pupae developed into keds, that is, two out of a total of 50. Both emergences took place during the first day.

Under the following five sets of conditions the development of the pupae was absolutely inhibited, viz., (1) pupae on moist sand in incubator at 96·8° F., (2) on sand on lawn at temperature varying from 34 to 86° F., (3) on sand on lawn at temperature varying from 47 to 84° F., (4) on moist sand in cellar at temperature varying from 50 to 59° F., and (5) on dry earth in cellar at temperatures from 50 to 59° F.

The members of the family Hippoboscidae to which the sheep louse-fly, tick, or ked belongs are all parasitic in the adult stage upon birds or mammals, and as in the other families of the sub-order Pupipara the larva is retained in the body of the female until it is nearly ready to transform into the pupal stage. The ked or tick spends its whole life upon the host; the nearly fully developed larva is extruded into the wool when it transforms about 12 hours later into a pupa, from which it is, however, indistinguishable except in hardness and colour. This pupa, or more correctly puparium, since the pupa is enclosed within the larval skin, is securely attached to the fleece by a glutinous substance which is extruded by the female with the nearly fully developed larva.

The incubation period of the pupa varies according to the temperature. On sheep kept in a stall in winter when the temperature varies from 43 to 47° F. the period was found to be 22–24 days. In summer when the temperature varied from 47 to 72° F. the period on stalled sheep was found to be 19–21 days. Young female keds were found capable of copulating five days after their emergence from the pupae, but when only a few insects were liberated on, and allowed access to all parts of, the host the period was usually longer owing to the chances of early mating being lessened. Under these conditions mating took place on the 6th to the 14th day. The young female extrudes the first pupa in a minimum period of 13 days after emergence from the pupa. The usual period, however, is longer, that is, up to 23 days. It appeared that pupae might be extruded, for a time at least, at an average rate of one every 9 days, but work in this connection was limited and the length of life of the adult ked was not ascertained.

The period of viability of the ked when removed from the host and kept without food is longer under South Australian conditions than has been recognised elsewhere. In Europe and America it was found that the ked did not live to the 8th day and that most of them died in from 2 to 4 days. Sweet and Seddon showed that they could be kept alive off the host in Victoria for $11\frac{3}{4}$ days under cool uniform

conditions in early summer. Hill found that even this latter period might be exceeded, as was the case in no less than 10 out of the 46 groups of keds experimented with.

The adult ked lives longer apart from the host than does either the unfed insect under one day old or the young insect of 3–7 days old which has fed upon the host. The female in nearly all cases outlives the male. The longest period for which an adult female was kept off the host and without food was up to the 18th day. This ked was kept in a dish of sheep pen sweepings, containing a portion of a tree trunk, in a dry well-ventilated cellar where the temperature was very uniform in contrast to extremes above and below in outside temperatures. Under similar conditions groups of keds under one day old (unfed) and from 3 to 7 days old (fed) all died in 14 days. Under more natural out-of-door conditions the maximum time of survival was, for adult keds 11 days, for 3–7 days old (fed) keds 10 days, and for 1 day old (unfed) keds 8 days, on a small part of a tree trunk with loose bark on a sheltered lawn, and 10, 8, and 7 days respectively when on the surface soil on same lawn, although in each case the majority of the keds died before the end of the 4th or 5th days.

These experiments and observations show that there is some slight ground for the contentions of sheep owners who maintain that sheep previously freed of keds by dipping may become re-infected with other keds that have been left on grass, bushes, or posts, etc., or with young keds that have emerged from pupae dislodged from the fleeces of infected sheep. Hill, however, states that he is unable to trace any record of keds or their pupae having been found in such circumstances, although the transference of the adult insects from the fleece to bushes, posts, logs, etc., appears to be extremely probable in view of the fact that these insects are in the habit of coming to the surface of the fleece in warm weather. It is also possible that a few pupae are dislodged while the host is engaged in rubbing itself against such objects as fence posts. It is possible that other pupae fall from the fleece to the ground as a result of the dipping fluid or heavy rain dissolving the glutinous matter which attaches them to the wool. Even under favourable conditions the number of keds which survive for more than four or five days off the host and subsequently re-infect ked-free sheep must be extremely small, much too small to account for a general re-infection of a clean flock or even a moderately large number of its members.

Hill believes that while a certain amount of re-infection is very probable most of the parasites found on previously dipped sheep are the progeny of pupae extruded prior to dipping and which have escaped the destructive action of the fluid. This view was supported by the author's own experience with dipping fluids inasmuch as all sheep used in his experiments had to be dipped twice, even though strong solutions were used for the first dipping.

Hill (Gerald F.). **Relationship of Insects to Parasitic Diseases in Stock. Part I. The Life-History of** *Habronema muscae, H. microstoma,* **and** *H. megastoma.*—*Proc. Roy. Soc. Victoria.* Vol 31. (New Series). Pt. I. pp. 11-76. With 8 plates comprising 49 figs., & 9 tables.

Although the life history of *H. muscae* has been known for some years as the result of investigations made in the United States of

America by RANSOM (B. H.), 1913, there are no records of any such investigations in Australia, where variations tend to occur in the case of the life cycle of certain parasites owing chiefly to certain climatic and other conditions. As to the life histories of *H. microstoma* and *H. megastoma* nothing appears to be definitely known either in Australia or elsewhere.

During recent years attention has been directed to these parasites, which are more or less common stomach parasites of the horse, on account of their causal relationship to the conditions known as "summer sores" (habronemic granulomata and habronemic conjunctivitis), attributed to the larval forms of the parasites. Further, it is stated, splenic and stomach abscesses of the horse due to *H. megastoma* appear to have become of more frequent occurrence during the last few years and there is reason to believe that under certain conditions the mortality caused is considerable.

Attention had to be paid to two essential conditions in carrying out experimental work, viz., (1) to obtain a pure culture of the parasite under investigation, and (2) to obtain absolutely "clean" flies, that is, flies quite uncontaminated with any sort of helminth infection. Pure cultures were obtained by taking all the eggs and embryos used in the experiments direct from gravid females and breeding them in sterilised fresh horse faeces, and the technique for obtaining clean flies is described at length.

(A). *Habronema muscae* Carter. Until quite recently the presence of this helminth in the stomach of horses in Victoria was not recognised, although *H. megastoma* and *H. microstoma* were well known. It is probable, however, that the worm was often mistaken for *H. microstoma*. On examination of the parasites found in 39 horses' stomachs during this work the author found that 33 harboured *H. muscae*. The results of the author's experimental work on the worm were practically a confirmation and extension of RANSOM's observations.

The embryos passed out in the faeces from the horse are taken up by the house-fly larvae, which have been oviposited on the faeces, and the faeces remain infective for up to at least 8 days after having been evacuated. The fly larvae are known to be capable of becoming infected when they are from 48 hours up to 9 days old. After a slight amount of development in the faeces the worm embryo enters the fly larva, and continues to develop in the fly pupa and in the adult fly. When it has reached this stage it is ready to develop in the stomach of the horse. RANSOM suggested that the horse might be infected in three ways, (1) by ingestion of dead infected flies, which he considers a common source of infection, (2) by ingestion of the parasite in water or moist material, and (3) by ingestion of the parasite after its escape from the fly whilst feeding upon the mucous membrane of the horse's mouth. Hill's experiments do not give any support to the second of these suggestions inasmuch as no evidence was obtained to show that the parasite escaped from the fly. Again, regarding the third theory, RANSOM himself says that there is nothing to indicate that the larvae escape from the fly while feeding upon moist surfaces, and no support was obtainable in the author's experiments. The ingestion of both living and dead infected flies therefore in all probability provides the normal means by which the larvae find their way into the horse's stomach. There is no doubt but that living flies

and flies that have recently succumbed are quite commonly ingested by horses from drinking troughs and with fodder.

JOHNSTON (1912) recorded the occurrence of the larvae in *Stomoxys calcitrans* and *Musca domestica* in Sydney and in *Musca domestica* in Brisbane. Hill, however, on two occasions supplied faeces massively infested to both the house-fly and the stable-fly in the same jar with the result that the house-fly became heavily infected whilst the stable fly disclosed no larvae.

(B.) *Habronema microstoma* Schneider. In the adult stages *H. microstoma* bears a very close similarity to *H. muscae*, but the species are distinctly different and after a little experience may be easily separated even when living. Although well known in Victoria it is not so frequently met with as *H. muscae*. Whereas *H. muscae* was found in 33 out of 39 horses' stomachs *H. microstoma* was found in only 13, and in all cases in which both species were found in the same stomach the former greatly outnumbered the latter. *H. microstoma* was not found in 11 stomachs examined in the months May to August.

Experiments were carried out to determine the relationship of the house-fly (*Musca domestica*) and the stable-fly (*Stomoxys calcitrans*) to the embryos of *H. microstoma*. The house-fly alone was used in five experiments. In two of these no infection took place while in the three remaining cases a total of only three individuals became infected, each with a single parasite; in all 419 house-fly larvae, pupae and flies were examined. In one of these experiments house-fly larvae failed to become infected in a culture which subsequently infected 100 per cent. of the stable-flies examined. The two species of fly larvae were at different ages but other experiments with larvae of the same age from the two species placed together would lead one to believe that the age of the fly larvae had no influence at all on the result, as the worm larvae were actively alive. The stable-fly alone was used in one experiment with the result that 100 per cent. of the individuals subsequently examined were found to be more or less heavily infected. In another experiment both species of fly larvae were introduced at the same time to a culture of *H. microstoma* with the result that 100 per cent. of the stable flies were heavily infected while the house flies were negative. In all, 71 stable-fly larvae, pupae, and adult flies were examined, of which 48 were infected.

In the other two experiments a double culture, i.e., of *H. muscae* and *H. microstoma*, was given as food to house-flies and stable-flies placed in the same cage. Both of these experiments proved beyond doubt that, while *H. muscae* only occurred in the house-fly, *H. microstoma* occurred almost entirely in the stable-fly, and only rarely in the house-fly, even when these flies were placed in the presence of an intense infection.

Upon the results of these and other experiments described, supported by the finding of what was almost certainly a larval *H. microstoma* in a naturally infected stable-fly, the author concludes that the stable-fly is the principal intermediate host of *H. microstoma* and that the house-fly only occasionally, possibly only accidentally, acts as an intermediary. Consideration is, however, given to the fact that deposits of fresh horse faeces are not the usual breeding places of the stable-fly. The fly breeds frequently if not generally in decaying grass, straw, and similar matter and also in loose soil

contaminated by stable effluents. The larvae and pupae are to be found commonly, however, in the older portions of manure heaps and in such situations as are to be found in crowded horse yards. It was proved in the course of these investigations that under certain conditions *H. microstoma* embryos could remain infective in faeces for a period of at least 15 days.

The fact that fresh faeces are not usually used as a breeding ground by the stable-fly presents no obstacle to the fly acting as the natural intermediate host of this worm if one bears in mind certain facts, viz., the lengthy period of viability of the embryo, the relative scarcity in horses' stomachs of the adult stages of this worm as compared with *H. muscae*, and the apparent seasonal occurrence of *H. microstoma* which, from the author's observations, appear to be confined to a period of from September to January. Unlike the adult house-flies which are to be found in Victoria more or less plentifully throughout the year stable-flies are extremely scarce during the winter and spring. These flies generally appear in numbers during the latter part of December, become increasingly numerous in January, February, and March, and gradually disappear until very few remain in June. It is not easy to explain why no *H. microstoma* was found in animals examined post mortem during late January to early March since the fly host was numerous, the season very mild, and the horses came from various places.

The experiments showed that the life history of *H. microstoma* was somewhat similar to that of *H. muscae*. The embryos passed out in the faeces from the horse are taken up by the larvae of the stable-flies which have oviposited on the faeces. The faeces remain infective for up to at least 15 days. The fly larvae were found to be capable of becoming infected when from 2 days up to 9 days old. After apparently undergoing a slight development in the faeces the embryo enters the larva of the stable-fly, develops through certain stages, and the development is continued in the fly pupa again through certain stages, and then in the adult fly, in which condition it is ready to develop in the stomach of the horse, where it reaches maturity. Infection of the horse's stomach is brought about undoubtedly at least in part by ingestion of living and dead infected flies.

Whether the living infected stable-fly is able to infect the definitive host with the parasite by means of direct inoculation into the skin remains unproved. Failure to obtain infection in this way was the result in the author's experiments but this may have been due to the clogging of the proboscis by the 15 and 20 parasites, respectively, present in it in the two cases specially mentioned. This clogging would prevent the fly from properly piercing the skin and over infection would thus defeat the object of infection of the intermediate host.

(C.) *Habronema megastoma* (Rudolphi) 1819. The adult form of this worm is easily distinguished from the other two worms, *H. muscae* and *H. microstoma*, by its smaller size and the very characteristic form of its anterior end. It would appear from the author's observations that the adult stages of the worm occur naturally only in tumours in the definitive host. Their rare occurrence on the external surface of the tumour or adjacent membrane would be due to their escape from their natural surroundings after the death of the host. In the 39

horses' stomachs examined by the author 19 contained well developed tumours of *H. megastoma*. The adults are also known to occur in the splenic abscesses which appear to have become more common within recent years and to have been responsible for an increase in mortality in horses during certain seasons and in districts in south-eastern Australia. In none of the stomach tumours mentioned above were any forms of *H. muscae* or *H. microstoma* discoverable. For experimental purposes the contents of such tumours were therefore used to infect sterile faeces with the eggs and embryos of the worms.

In the experiments carried out to determine the relationship of the house-fly and the stable-fly to the embryo of the worm the house-fly exclusively was used in four experiments and infection took place in three of these experiments. It was not possible to account for the failure to infect flies in the fourth experiment. In the positive experiments 35 per cent., 52 per cent., and 15 per cent., respectively, of the larvae, pupae, and adults examined were infected with from 1 to 16 parasites each.

The stable-fly exclusively was used in two experiments, in both of which there was no infection. The experiments would therefore show that the house-fly is an intermediate host of the worm and that all the available evidence is against the stable-fly acting even accidentally in such a capacity. Thus embryos passed out in the faeces from the horse are taken up by the larvae of the house-flies which have oviposited on the faeces. The faeces remain capable of infecting the fly larvae for up to at least 15 days after leaving the rectum. Fly larvae were found capable of becoming infected when three days up to five days old. After a certain amount of development in the faeces the embryo enters the larva of the house fly, then continues to develop through the fly pupa and adult fly, in which condition it is ready to complete its development in the stomach of the horse, where larvae in such a state of development were detected. *H. megastoma* was not found in any of the 182 adult house-flies and 63 adult stable-flies caught in the stable during the period May to November 1917. In its three last stages in the body of the fly *H. megastoma* may be differentiated from both *H. muscae* and *H. microstoma* in corresponding stages of development.

The paper contains a considerable amount of carefully worked out detail concerning the morphology of the adult worms and of their so-called six larval stages. The 5th stage is interesting inasmuch as it is that in which the spinous character of the tip of the tail is seen in these worms. It was the presence of such spinous processes on the tails of worms isolated from "summer sores" that first led Railliet to suspect that they were in reality stages in the life cycle of the spiropterous worms found in the horse's stomach [this *Bulletin*, 1916, Vol. 4, No. 3, p. 102].

Spitz (G.). **Contribution à l'étude des "plaies d'été" (Habronémose cutanée des équidés.)** ["Summer Sores." Cutaneous Habronemiasis of Equidae].—*Rec. Méd. Vét.* 1920. Apr. 15–May 15. Vol. 96. Nos. 7–9. pp. 208–216.

Spitz claims to have had considerable clinical experience with the above disease in the course of observations carried out for many years in Argentina. These observations lend support to the views

recently put forward by certain authors as the result of experimental work upon the condition [this *Bulletin*, Van Saceghem, 1917–1918, Vol. 5, No. 4, p. 248, & Vol. 6, No. 3, p, 171].

The disease is particularly one of tropical countries and even in such climates it presents a well-known periodicity ; that is, the lesions appear or relapses occur and are particularly persistent during summer weather, while they show a marked tendency to cicatrise during the winter—hence the term "summer sores." Moreover, it is during the hottest days of summer, when the barometer registers a low pressure and the atmosphere is very humid, that pruritus becomes most intense and the sores show most tendency to spread. The reason underlying this is that it is on such days that the flies that transmit the infection are most active.

Contrary to what has been stated by certain authors Spitz declares that the sores may be observed on all parts of the horse's body, and develop frequently at the seat of firing or of an accidental or operation wound, of any size and in any position. The most commonly affected sites, however, are those most liable to minor injuries (fetlock, knee, pastern, coronet), to harness wounds (withers, girth, poll), or to the irritant action of normal or accidental secretions (inner canthus of eye, sheath, urinary meatus).

The granular dermatitis constitutes always a secondary lesion following upon a long-standing or recent pre-existing lesion. It is not thought possible that the sores can originate on intact skin. There was always noticeable a breach of the epidermis as the starting point whether this be a wound or a slight erythematous condition such as might be caused by the friction of harness on the congested sweating skin or by the irritant action of tears or other secretions. The effects of the irritation may often be so slight as to pass unperceived and in such cases the lesion appears to commence on intact skin. It is highly necessary to realise from a prophylactic or etiological point of view that an initial lesion no matter how minute is the indispensable forerunner of a summer sore.

In the absence of direct experimental proof the author adduces a number of points which support the views of investigators that the disease is a cutaneous habronemiasis :

(1) During summer every wound and discharging inflammatory lesion of the skin or visible mucous membranes not protected by a dressing is liable to become transformed into a summer sore.

(2) Every wound protected by a dressing is shielded with certainty from infection, even when such a wound is to be found on a horse affected elsewhere on its body with one or several sores in the course of development. Infection of internal origin is thus out of the question.

(3) These deductions are applicable to suppurating and complicated wounds as well as to simple or recent wounds, and one may allow a suppurating wound to become actually macerated in its own secretions under a dressing without its becoming transformed into a summer sore. The part played by the dressing is thus simply to protect the wound, and it does not act in virtue of its absorbent or antiseptic properties. Moreover, the same result may be obtained by the application of a very loose pad of gauze which does not come into actual contact with the wound—on the limbs for example.

(4) The application of an antiseptic protective dressing to a formed summer sore does not seem to have any appreciable effect upon its development. Pruritus in particular is persistent and the sore continues to grow. This would indicate that the parasite probably multiplies *in situ*.

(5) In natural conditions infection is not transmitted by contact of animal with animal or through the medium of soiled litter, and the presence of a horse affected with sores among other, unaffected, horses does not constitute a source of danger provided the sound animals do not themselves carry skin lesions exposed to the action of the fly. The author quotes an interesting observation bearing on this point.

(6) The disease is not transmitted through sound skin by the bites of Stomoxys, and the principal, and undoubtedly exclusive rôle in the propagation of summer sores is played by the house-fly.

In discussing the etiology of the condition the author points out that NOCARD in 1901 described the presence of parasitic nodules resembling glanders nodules in the lung of a horse infected with summer sores. Since that time these lesions have been often observed. According to Spitz these lesions appear to be of constant occurrence and he even found them in large numbers in horses affected with summer sores. In one case described the lungs were simply packed with nodules. This seems to the author to indicate that the Habronema embryos pass into the general circulation, and the possibility is suggested that the embryos introduced by the flies into the sores, pass into the circulation, develop into adults in the stomach, and subsequently the larvae from these develop in the body of the house-fly [but this view is contrary to what is known regarding the life cycle of Habronema worms. See above article by HILL.—ED.].

The larvae deposited by the fly on the moist surface of the sores finds conditions favourable for development, and at all events set up the most intense pruritus, congestion, and granulation. The lesion extends no doubt after the introduction of further parasites. The parasite burrows into the depth of the sore and determines a marked hyperplastic reaction, with the formation sometimes of a considerable amount of connective tissue. In long-standing sores one may find at varying depths granulations resulting from the encysting of dead parasites. It is believed, however, that the greater number of the parasites passes by way of the lymph or blood streams into the general circulation.

In the present stage of our knowledge prophylaxis resolves itself into measures for combating the flies—the application of a protective arrangement, covering dressing, a pad of gauze or linen, etc., to the initial wound. Hygienic treatment of certain regions should not be neglected, particularly the sheath, eyelids, nostrils, and commissures of the lips, and also harness wounds. Moreover, the droppings of horses should be quickly removed, fly larvae destroyed by the use of parasiticides, etc., but it is admitted that the measures at present available for dealing with flies are by no means satisfactory. Attempts at ridding the parasites from their natural habitat in the horse's stomach should also be borne in mind.

With regard to curative treatment the only form of treatment which gave satisfactory results in the author's hands was surgical treatment, consisting in the total extirpation of the lesion and the application subsequently of a protective dressing to the operation wound. Surgical interference should take place early, in order to avoid greater loss of tissue later. If, however, the sore is very extensive or the site of the lesion makes it difficult or impossible to apply a protective dressing (e.g., the sheath) it is better to delay the operation until the commencement of the winter, when the lesion undergoes spontaneous retrogression and extirpation is easy; the absence or diminished activity of the flies enables one also to employ simple antiseptic treatment to the resulting wound instead of a protective dressing. There appears to be one exception to this rule, viz., in the case of sores situated around the urinary meatus. These may be readily excised by means of a pair of scissors.

In cases where operative treatment is contra-indicated an appropriate local treatment many be employed which combines a parasiticidal action, as deep-reaching as possible, with a local anaesthetic action having as its aim the diminution of the pruritus which is the great obstacle to cicatrisation. After many unsuccessful attempts the author became satisfied in this respect with the use of camphorated phenols mixed with a little methylene blue. The addition of camphor to phenol gives a pasty or syrupy liquid product—depending upon the proportion of either constituent. The best results were obtained by using a mixture consisting of salol 10 grammes, camphor 1 gramme, with some methylene blue added. This mixture was applied locally, and simultaneously a few injections of this preparation with the addition of some guaiacol were made into the depth and around the base of the lesion.

HODGKINS (J. R). **A Note on a Type of Marasmus amongst Horses in India.**—*Vet. Jl.* 1920. June. Vol. 76. No. 6. pp. 207–210.

Writing from Secunderabad, India, this officer of the Royal Army Veterinary Corps states that the presence of Habronema worms (Spiroptera) in the stomachs of horses in India causes a considerable amount of debility and emaciation in these animals. He illustrates his article by records of 10 cases including post-mortem examinations. The worms were present in considerable numbers in these cases.

One animal that had exhibited diarrhoea and extreme emaciation showed many sub-mucous abscesses containing *H. megastoma* in the stomach; there was local peritonitis above the area of attachment of the spleen, which organ was much enlarged and undergoing suppuration [compare extract of Hill's work in Australia p. 198.] There were abscesses also in the mesenteric glands. Still another case showed an extensive suppurative peritonitis and at the apex of the spleen there was an evacuated abscess cavity. On opening the stomach a large sub-mucous abscess corresponding in position with the abscess situated on the external surface and involving the spleen was found. This abscess was due to *H. megastoma*. A second sub-mucous abscess was also present. The surface of these abscesses presented an appearance similar to that of the uterine cotyledon of a cow.

In these cases besides the sub-mucous abscesses due to *H. megastoma* there were large numbers of worms (*H. microstoma* and *H. muscae*) lying in the mucus on the surface of the stomach.

PORTER (Annie). **The Experimental Determination of the Vertebrate Hosts of some South African Cercariae from the Molluscs *Physopsis africana* and *Limnaea natalensis*.—*Med. Jl. of South Africa.*** 1920. Jan. Vol. 15. pp. 128–133. (Reprint).

In this short paper the author gives a preliminary account of some experimental work performed in order to ascertain the larval stages of a number of flukes, found in the above two snails, which are the species most commonly encountered in South Africa. The adult forms in the vertebrate host of these larval flukes are also determined.

The adults proved to comprise representatives of four great groups of Trematoda, viz., (1) the Schistosomes, of which *Schistosoma haematobium*, the agent of human urinary bilharziasis and *S. mansoni* of human bilharzial dysentery were the most important members; (2) the Distomes, represented by the liver flukes of cattle and sheep; (3) Echinostomes, previously described in mammals and birds and now recorded by the author as parasites of Amphibia; and (4) Monostomes, proved by the author to be parasites of Amphibia.

Natural methods of infecting the vertebrate hosts were used in each case; the hypodermic needle in the author's hands yielded indifferent results. Work in connection with the Schistosomes, which are of interest mainly in human pathology, is first described. Infection of the molluscs with *S. mansoni* was uncommon. *S. haematobium* was much more frequent in *P. africana* than in *L. natalensis*. Adult schistosomes were obtained in laboratory animals by submitting them to such natural modes of infection as bathing or exposing them to water containing the cercariae and by causing them to drink water so contaminated.

Distome cercariae were also found in both molluscs. The author's results in the determination of the adult form and of the final hosts of the cercariae were obtained by feeding certain vertebrates with the parasites found in *L. natalensis* and believed to be identical with those named *Cercaria pigmentosa* by CAWSTON in 1919 [this *Bulletin*, 1919, Vol. 7, No. 4, p. 208]. According to Porter the livers of snails infested with the parasite appear streaked with white threads which sometimes show orange and black markings. These threads are the rediae, the intestines of which contain orange and black contents. The rediae vary in size according to the season and to the particular time of reproductive activity of the fluke in the snail. Exceptionally, the parasites measured 12 mm. long, a few were from 6 mm. to 7 mm., but the majority were 1·5 mm.–2 mm. in length. The rediae produced cercariae, and daughter rediae appear to be formed only towards the end of the multiplicative activity of the parent rediae.

The cercariae are active organisms and vary in appearance according to their degree of activity. Thus, the body of a cercaria measures about 500μ when extended fully, while when contracted it appears rounder and may measure only 250μ. The anterior sucker is fairly prominent and the posterior one easily seen. The intestine is that of a typical distome. In life the body is crowded with masses of cysto-

genous granules ("pigment" of CAWSTON) which largely obscure the finer details of the structure of the parasite. The granules are soluble in alcohol, chloroform and formalin, and so are not well seen in preserved material.

When an infected snail is isolated in water the cercariae readily leave it and can be seen with the naked-eye swimming actively in the surrounding water. After a time they leave the water and creep up the stems of any water plant in their vicinity, or failing water plants or grass they creep up on to the snail itself. Each cercaria commences to extrude the cystogenous granules from its body and soon casts its tail. The body then contracts into a spherical mass surrounded by a black cloud of granules. These gradually condense and form a thick cyst wall which hardens on exposure and contracts appreciably. The encysted cercaria shows its two suckers, forked gut, and the remains of the cystogenous granules. As many as 1,070 perfect cysts are said to have been obtained from one *L. natalensis*, and several hundreds from one snail were common. The encysted parasites on herbage by the water side are in favourable situations for ingestion by any herbivorous animal.

By direct experiments in feeding herbivorous animals (sheep, rabbits, and guinea-pigs) and of omnivorous animals (rats, mice) on green barley and cabbage contaminated with the cysts the author succeeded in obtaining adult flukes, which corresponded with the adult trematode known as *Fasciola gigantica* Cobbold, reported from oxen, buffaloes, sheep, goats, giraffes, and in one instance from man. A few notes on some of the experiments are given.

A rabbit was fed with green food contaminated with cysts from *L. natalensis*. After some time it showed signs of emaciation and died 64 days after the infective feed; over 20 adult flukes were obtained from its liver post-mortem. The liver was enlarged and greyish with white patches which proved to be flukes; some of these emerged from the disintegrated capsule and moved about actively. There were also found recent haemorrhages into the connective tissue around the terminal part of the rectum and the superficial fascia of the lower part of the abdomen and the posterior aspect of the thighs; there was a large haemorrhagic sac between the superficial and deep muscles of the thigh. These haemorrhages contained one or more flukes.

Similar results were obtained with a guinea-pig, which died 74 days after the infective feed. The morphology of the flukes was the same as that of the rabbit flukes.

A young sheep bred from and belonging to a stock known to be free from liver fluke was fed with green barley contaminated with cysts from *L. natalensis*, two such feeds being given, at 24 days interval. On the first occasion only a few cysts were available but on the second about 250 cysts were administered. The animal died 119 days after the second infective feed and 223 adult flukes were recovered post-mortem. The faeces were examined daily but no trematode eggs were detected. 64 days after the second feed the animal was noticed to be less active and to lie down a great deal. This attitude continued at intervals until death. The animal refused most of its food for seven days before it died but ate its mash and some green barley on the day prior to death. Diarrhoea occurred during the last three days.

Post-mortem. The body was well nourished and fat. The liver showed marked peri-hepatitis and was greenish in colour with numerous small blackish areas that proved to be haemorrhages. There was slight oedema. The bile ducts were greatly thickened and cirrhotic. The kidneys were normal except that they were small and pale and one fluke was recovered from the pelvis of the right kidney. The intestines were heavily bile-stained and flukes were present in the intestinal canal, which also showed numerous small haemorrhages and contained free blood. All the blood vessels of the mesentery were engorged. A small haemorrhage beneath the skin near the anus contained one fluke. The other organs of the body were normal. 189 flukes were removed from the liver ; the bile ducts were blocked in parts and two or three flukes entangled together were found in these places.

The adult flukes varied in size, large ones being 45 mm. long and about 7 mm. broad while small specimens were about 20 mm. long. Sexually immature forms were also present varying in length from 5 to 19 mm. and in breadth from 2 to 4 mm. The sides of the body were nearly parallel and there was a short cephalic cone. The anterior sucker was distinct, about 1 mm. in diameter, the posterior sucker was prominent and in large specimens reached 1·8 mm. in diameter. The pharynx was well-marked, the oesophagus short, and the lateral, branching, intestinal caeca were directed slightly backwards. The reproductive system was typical of Fasciola. There were two testes, placed one behind the other and much branched; each had a vas differens, and the vasa deferentia united anteriorly. The ovary was relatively small and was branched. The uterus and oviduct were convoluted. Yolk glands were present and were greatly branched. The vitelline ducts were readily seen, especially in the transverse junction, which was dilated centrally into a vitelline receptacle. A large shell gland was present.

The eggs were large, measuring about 175μ long and 85μ broad. The fluke was identified with *Fasciola gigantica* Cobbold, known as a parasite of oxen, buffaloes, sheep, goats, giraffes, hares, and rabbits in Africa. The life cycle and intermediate host of this parasite in South Africa is thus determined for the first time [this *Bulletin*, 1918, Vol. 6, No. 2, p. 107]. It is stated that this parasite may be much more common in sheep and cattle in South Africa than it has been supposed to be. Further researches are stated to be in progress.

CAWSTON F. G.). **i. Parasitic Disease and Research. Cercariae and Snails ; Points to be Cleared Up ; Cleansing of Pools.** *Farmer's Weekly.* 1919. Apr. 23. **ii. The Value of Domesticated Ducks in Preventing Diseases.**—*The Natal Poultry Journal.* **iii. Liver Fluke. A Possible Blood Test ; Fresh Water Snails Wanted.** *Ibid.* 1920. Apr. 28. [Reprints received 22nd June 1920.]

Reference to Cawston's researches upon the life cycle of South African trematodes has already been made in this *Bulletin* [1919. Vol. 7. No. 4. p. 208]. In various parts of the Union cattle and sheep are affected with a common reddish, conical-shaped, amphistome parasite of the intestine, and it appears that they become infected by

eating damp grass containing the encysted cercariae, which possess a sucker at either end of the body, and have as intermediate host a common fresh-water snail, *Isidora schakoi*. It would appear that there are many different species of the adult worm, and it is probable that more than one species of fresh-water snail may act as their respective intermediary host.

Work was also done upon the life-cycle of the distomes or liver flukes, affecting the sheep and ox in South Africa [this appears to have been confirmed by PORTER'S researches—see above extract]. In addition investigations were made upon the important bilharzia trematode of man. Hitherto it has been thought that one species alone was responsible for the human disease in South Africa. Recently, however, the author has isolated four different parasites.

The prevention of these allied affections in man and other animals calls for an attack on the fresh water snail. The author recommends two agents for this purpose, viz. (1) Ross's larvicide, which is said to have a proved efficacy and consists of crude carbolic acid, 300 gallons, resin 200 lbs. and caustic soda 30 lbs.: one part of the mixture, which is well boiled in the course of this preparation, added to 5,000 parts of water, will kill any larvae or cercariae in less than five minutes; (2) lime, which also acts as a fertilising agent, a bag of lime to every thousand cubic yards of water will appreciably diminish the number of snails found in water-holes.

Discussing the value of domesticated ducks in preventing these affections the author states that examination of several hundred snails from the pools around Durban shows that they are responsible for at least four distinct diseases in man and beast. Over 200 adult bilharzia worms were isolated from seven animals that had been infected from the water. Snails are often found in the mud that clings to the claws of birds and there is little doubt that wild birds carry snails from pool to pool. It thus appears that stretches of water containing wild duck harbour the various species of fresh water snail in greatest numbers. On the other hand where the domesticated duck was found it was seldom that it was possible to collect fresh-water snails in any number. A number of observations seemed to bear out this view and it would seem that in view of the economic importance of bilharzia disease in human beings and of liver-fluke disease in sheep every encouragement should be given to residents and particularly the Indian population in the Durban suburbs to keep domesticated ducks.

Cawston advocates the use of the complement test in detecting trematode infestation of man and animals. The antigen for the test, in the detection of Bilharzia disease in man, consists of an extract of infested liver of *Physopis africana*. Inasmuch as it is now known that the snail *Limnaea natalensis* harbours the cercarial stage of *Fasciola gigantica*—the giant fluke of the sheep and ox—one might apply a similar blood test for the diagnosis of so-called liver-rot; an alcoholic extract of infested specimens of this common fresh water snail would be used as antigen. Judging by analogy with the results obtained in the bilharzia test one might expect to get positive results, by using the same extract, in animals harbouring *Fasciola hepatica*. These common flukes of sheep and cattle often occur together. Infected fresh-water snails are therefore required for further investigation.

SCHWARTZ (Benjamin). **The Biological Relationships of Ascarids.**—*Jl. of Parasitology.* 1920. Mar. Vol. 6. No. 3. pp. 115–123.

The experiments described in this paper were undertaken in order to determine whether by means of immunological reactions *Ascaris lumbricoides* which occurs in man could be differentiated from *Ascaris lumbricoides* which occurs in the pig. Morphologically the forms from the two hosts appear to be indistinguishable. The name *Ascaris suum* or *Ascaris suilla*, which is used by certain writers to designate the ascarids which occur in swine is not generally accepted by zoologists for the reason that the classification of animal parasites is based on morphological and not on host relationship. A rather extensive study of the chemistry and toxicology of Ascaris was made by FLEURY in 1912. In this paper Schwartz describes a series of experiments with various ascarids in which he employed the precipitin test and the anaphylactic test in an endeavour to differentiate them.

"Summary and Conclusions. (1) The blood serum of rabbits immunized to salt-solution extract of *Ascaris lumbricoides* (from swine) causes the formation of precipitates when added to salt solution extracts of various ascarids (Ascaris, Belascaris, Toxascaris, Ascardia). The precipitin reaction as applied to extracts of these parasites is therefore a group reaction.

"(2) By the use of proper dilutions heavier and more rapidly appearing precipitates are produced when rabbit serum immunised against *Ascaris lumbricoides* is added to salt solution extracts of *Ascaris lumbricoides* than when it is added to similar extracts of other ascarids. Extracts of species of the same genus (*Ascaris lumbricoides* and *Ascaris equorum*) show less difference in that respect than extracts of worms belonging to different genera (Ascaris, Belascaris, Toxascaris, Ascaridia). The results of the precipitin tests correspond, therefore, to the zoological relationships of these parasites.

"(3) Extracts of *Ascaris lumbricoides* from man do not appear to be distinguishable from extracts of *Ascaris lumbricoides* from swine so far as the results of the precipitin test are concerned. Apparently, the forms from the two hosts are biochemically as well as morphologically indistinguishable.

"(4) Small quantities of precipitating serum sufficient to cause the formation of precipitates in salt-solution extracts of ascarids failed to produce precipitates in similar extracts of unrelated nematodes (Dictyocaulus, Strongylus).

"(5) The results obtained by means of the anaphylactic test appear to be in a general way in agreement with the results of the precipitin test, although a considerable degree of variation was noted as regards the reactions of guinea-pigs to injections of similar extracts. Definite conclusions from the experiments on anaphylaxis are not justified in view of the limited number of experiments."

YOSHIDA (Sadao). **On the Resistance of Ascaris Eggs.**—*Jl. of Parasitology.* 1920. Mar. Vol. 6. No. 3. pp. 132–139. With 11 Tables.

In 7 per cent. sulphuric acid the eggs developed into embryos but sooner or later they all died. In 0·5 per cent. carbolic acid or 20 per cent. formalin they were unable to develop into embryos. In 20 per cent. sulphuric acid or glacial acetic acid, or 15 per cent. formalin the eggs developed into embryos but subsequently died. In 0·6 per cent. carbolic acid or in 25 per cent. formalin the eggs were unable to develop into embryos. In 12·5 per cent. sulphuric acid or glacial acetic acid or in 15 per cent. and 20 per cent. hydrochloric acid the eggs in some instances developed into embryos but died later. 1·5 per cent. nitric

acid was not harmful to the development of the eggs. It was interesting to note that the embryos grown in a 0·5 per cent. solution of potash permanganate emerged from the egg shell alive. Eggs cultivated in 10 per cent. hydrochloric or sulphuric acid and in 15 or 20 per cent. formalin died within 15 days. Eggs in 0·6 per cent. carbolic acid, in 12·5 per cent. sulphuric acid or in 20 and 25 per cent. formalin were so injured as to be unable to develop further by the 8th day. Eggs in 15 or 20 per cent. hydrochloric acid could not develop by the 14th day. They retained the power to develop during 10 days in 0·5 or 0·6 per cent. carbolic acid. The important fact was that the eggs were unable to develop and ultimately died in human urine. The experiments from which the above results were obtained were carried out at room temperature in the summer and in the incubator at 31° C. in the winter. Urine appeared to act more effectively upon the eggs at a higher temperature (31° C.) than at a lower temperature (10° C.).

The influence of the reagents naturally depended upon the permeability of the egg coverings. For instance, formalin and sulphuric acid coagulated the albumen in the coating, in consequence of which the penetration of fluid was prevented. After prolonged action glacial acetic acid and nitric acid destroy or break down the albuminous membrane of the eggs but do not penetrate easily through the inner chitinous membrane. Eggs cultivated in these reagents therefore resist comparatively high concentration and survive longer. Hydrochloric acid acts in the same way. Carbolic acid, however, penetrated the egg membrane more easily than any of the other reagents used in the experiments. The urine contains several kinds of ferments by means of which the albuminous membrane of the egg can be dissolved, and the action of the ferments appeared to be accelerated by raising the temperature. Moreover, the concentration of the urine is so much higher than that of the egg content that the osmotic pressure is sufficiently great to facilitate the introduction of the urine into the egg shell.

Some experiments were made in order to ascertain the resistance of the eggs to cold. Mature eggs placed underground for five months proved distinctly infective, while mature eggs placed on the ground for nearly the same length of time were also infective. Immature eggs were placed on the ground for nearly five months, then transferred to the incubator for a month and kept at room temperature for four months, next they were placed in the incubator for two months, at room temperature for two months, and finally in the incubator for 19 days. Two guinea-pigs fed with these eggs and killed after a week, showed signs of infection.

HENRY (A.) & JOYEUX (Ch.). **Contribution à la faune helminthologique de la Haute-Guinée française.** [The Helminths of French Upper Guinea.]—*Bull. Soc. Path. Exot.* 1920. Mar. Vol. 13. No. 3. pp. 176–182.

During the years 1910–1911 a number of worms were collected from man and various other species of animals at the outpost of Kouroussa, French Upper Guinea. The following were the worms found infesting domesticated animals :—

Horse : *Strongylus edentatus* (Looss) ; *Oxyurus equi* Zeder ; *Cylicostomum* sp.

Gastrodiscus aegyptiacus (Sons). This trematode has on its ventral surface a large number of closely adjacent small papilliform suckers. The cuticle of some of the worms was almost black. While examining specimens of Gastrothylax collected from cattle in French Indo-China RAILLIET, Henry, and BAUCHE noted that the ventral sac contained blood. This fact had already been commented upon by POIRIER (1883), who thought that this sac played some part in the nutrition of the parasite by supplementing the insufficiency of the digestive tract. Henry and Joyeux proved also that *Gastrodiscus aegyptiacus* did actually contain blood in the cuticle covering the ventral surface by the use of Eschaïch's reagent. Gastrothylax parasites obtained from the antelope also gave the same reaction. On the other hand the Paramphistomes of cattle contained no blood. It is thus probable that in *G. aegyptiacus* absorption takes place by osmosis through the papillae on the ventral surface, supplementing that which takes place in the digestive tract.

Mule : *Strongylus vulgaris* (Looss) ; *Cylicostomum* sp.

Ass : *Strongylus vulgaris* (Looss) ; *Cylicostomum* sp. ; *Gastrodiscus aegyptiacus* (Sons).

Native ox (humpless, of the N'dama breed) : This animal is now bred in the country, having been imported from Fouta-Dialon in Upper Guinea after the pacification of the Soudan. It harbours *Oesophagostomum radiatum* (Rud.) 17 times out of 25 ; *Haemonchus contortus* (Rud.), very common in the fourth stomach ; *Paramphistomum*, probably *cotylophorum* (Fischdr.), and *Fasciola gigantica* (Cobb.) 9 times out of 100, causing intense infestation in one case out of 100.

Zebu : this animal is not bred in Upper Guinea but is imported by the natives from various districts of Upper Senegal and Niger. The parasites found were : *Tricocephalus affinis* Rud., rare (1 per 40). *Oesophagostomum radiatum* (Rud.), in 21 cases out of 25, often in considerable numbers (up to 240 were found in one caecum). *Haemonchus contortus* (Rud.), very common in the fourth stomach. *Setaria digitata* (Linst.) in the peritoneum.

The trematodes found were, *Paramphistomum*, probably *cotylophorum* Fischdr. in 8 cases out of 10 ; *Fasciola gigantica* (Cobb.) in 82 per cent. of cases, causing in 60 per cent. an intense infestation. This liver fluke was found once in the lung of a zebu, the liver of which was moderately infested ; at the base of the right lung there was a cyst containing several compartments in which the flukes were situated. They contained concretions similar to those found in the infested bile ducts. It is noted that this fluke has been recorded once in man in blood-stained sputum coughed up from the lungs. The giant fluke is much less common in the native ox than in the zebu. This is perhaps due to the rare occurrence of its intermediate host in Upper Guinea. As a general rule the oxen are less severely infested with parasites than the zebus, not only by helminths but also by trypanosomes.

Sheep : Native-bred sheep : *Haemonchus contortus* (Rud.), common in the fourth stomach. *Fasciola gigantica* (Cobb.) once only. *Cysticercus tenuicollis* Rud.

Sheep imported from Upper Senegal and Niger, from the same source as the zebus : *Trichocephalus affinis* Rud., twice out of five times in the caecum. *Oesophagostomum columbianum* Curtice, twice out of 35 times in the caecum. *Haemonchus contortus* Rud., common in the

fourth stomach. *Cysticercus tenuicollis* (Rud.); Paramphistomum sp. in the rumen. *Fasciola gigantica* (Cobb.), rare, twice only in a large number of cases examined. It is noted that in sheep, as well as in cattle, those that are born in the country harbour much fewer parasites than those which are brought along with the zebus from Upper Senegal and Niger.

Common fawn antelope (*Tragelaphus scriptus* Pall.): *Gastrothylax*, probably *minutus* Fischdr. (with blood in its ventral sac as mentioned above). *Setaria* sp. in the peritoneum.

Domesticated pig: *Oesophagostomum dentatum* (Rud.).

Native dog (crossed with jackal): *Ankylostomum caninum* (Ercolani).

Domesticated cat: *Belascaris mystax* (Zeder).

CHRÈTIEN (A.). **L'Onchocercose du boeuf de Madagascar.** [Onchocercosis (Worm Nodules) in Cattle in Madagascar.]—*Bull. Soc. Cent. Méd. Vét.* 1920. May 20. *Rec. Méd. Vét.* 1920. Apr. 30–May 30. Vol. 96. Nos. 8 & 10. pp. 168–172.

Among the rare internal parasites of the ox in Madagascar there is to be found, besides amphistomes in the rumen and filaria in the peritoneal cavity, a nematode worm, present often in abundance, in almost all the adult animals that came under the author's observation. It is of such common occurrence that it might be asserted that the parasite could be discovered in all cattle submitted to a careful examination. Investigations were made during the years 1917–1919 among adult cattle from Northern Madagascar slaughtered at the rate of 100 to 120 per day at the Preserved Meat Factory at Montagne d'Ambre, near Diégo-Suarez.

The parasites are situated in the connective tissue fascia adjacent to the ligaments and tendons, but they are not found actually within these structures. The lesions produced may be seen particularly within the loose connective tissue lying between the various layers of the ligamentum nuchae, and especially in the uppermost layer of the ligament, often near its attachment to the superior spinous processes of the first dorsal vertebrae. Specimens were found that had even penetrated slightly within the cartilaginous prolongation of the superior spinous process of the first dorsal vertebra. The parasites and lesions were, however, also quite numerous in the fascia surrounding the articular ligaments especially those of the knee and hock joints, and in the fascia of the tendons of the limbs. Precise indications are given as to the occurrence of the parasites in these situations. No parasites, however, were discovered in the aorta and in the abdominal wall.

When the parasite occurs singly, as it does fairly commonly in the limb tendons but rarely in the cervical ligament, it is not easy to demonstrate it and one has to dissect out carefully the fascia surrounding the tendon or even cut thin slices parallel to the tendon and examine them by transmitted light. One may then observe embedded in the connective tissue a worm about as thick as thin thread which is always more or less loosely entangled and almost impossible to follow along its whole length. Single specimens did not appear to provoke any naked-eye lesion in the surrounding tissue at this stage. By means of a fine needle one can easily extract the worm from the tissue in the

form of a fine lustrous thread often up to 10 to 12cm. long which assumes a corkscrew shaped disposition. This does not represent the whole parasite as the body becomes invariably ruptured before the extremity is reached.

If, however, instead of single specimens several worms are present in the same location, as is usually the case when the parasites infest the ligamentum nuchae, the fascia becomes slightly thickened and opaque. The thickening is readily detected on manipulation and the fascia is always closely adherent to the tendon at the part. These lesions are distributed in irregular zones of more or less considerable size and slightly brownish tint, and these zones are often surrounded by oedematous zones of fairly considerable extent. On close examination a certain number of parasites may be detected in the central zone of these lesions in the form of more or less abundant closely packed and entangled masses of worms. These produce a distinct inflammatory reaction in the invaded tissue. They can be again readily extracted partially, but they appear to have become less supple.

Other lesions present the aspect of a distinct chronic inflammation; the parasites within these are more compact, it is difficult to extract pieces more than 1 cm. in length, and the worm has become brownish and brittle.

In the ligamentum nuchae affected with the parasites in abundance and sometimes in the limbs one may often find greenish abscesses from the size of a pin's head to that of a pea.

Again in these situations one may often see a number of irregular nodules generally flattened, reaching up to 1 cm. in diameter and dull white in colour. These are filled with a desiccated caseous material.

The above appearances are said to represent successive stages in the development of the parasite.

Histological examination confirmed the author's observations with regard to the situation of the parasites, viz., in the fascia surrounding the tendons and ligaments and not within these structures. To commence with there appears to be no appreciable reaction, the worm simply burrows a cavity in the tissue, which does not react. Inflammatory phenomena are not manifested until after a certain lapse of time. Around the parasite a centre of sub-acute inflammation is formed, similar to that seen in the majority of worm nodules and characterised by the formation of a mass of concentrically disposed epithelioid cells. Fibrous tissue becomes formed without and the adjacent fascia becomes denser and sclerosed. The lesion remains at this stage while the parasite remains alive, but after its death the inflammatory phenomena become more marked and large nodules are formed, with caseous centres impregnated with alkaline lime salts which take on haematein staining deeply. The wall of these nodules is made up of an epithelioid zone and a fibrous zone, the thickness of which depends on the age of the lesion. The reaction extends to the connective tissue situated between the spirals of the worm which becomes converted into a sclerosed tissue infiltrated with numerous eosinophiles. Finally, the lesion becomes a centre of firm connective tissue traversed by a devious tunnel full of caseous material which replaces the dead parasite.

Microscopic examination of the parasites readily shows that one is dealing with nematodes with a thick striated cuticle showing cork-

screw-like thickenings often interrupted towards the sides and thus belonging to the genus Onchocerca Onchocercosis of cattle in Madagascar was recorded for the first time by PIETTRE in 1912 in a leg of beef imported into Paris. PIETTRE believed that the parasite was *Onchocerca bovis*, which had already been discovered by him in that year in French cattle. The author does not contribute to the view that the parasites he encountered belonged to this species. Perhaps they belonged to several species. The presence of the parasites does not appear to produce any symptom whatever in the living animal.

RANSOM (Brayton H.) & HALL (Maurice C.). **Parasitic Diseases in their Relation to the Live-Stock Industry of the Southern United States.**—*Jl. American Vet. Med. Assoc.* 1920. July. Vol. 57. (New Series Vol. 10.) No. 4. pp. 394–429.

The views of the above two distinguished helminthologists upon the relations of parasites and stockbreeding in tropical or sub-tropical countries are of great general interest. Hitherto the presence of the tick in the Southern United States has stood solidly in the way of a prosperous cattle industry, and has prohibited highly developed agriculture. Now the tick is rapidly disappearing from the South and will undoubtedly soon be exterminated from within the borders of the United States. That Southern agriculture has been fundamentally affected by tick eradication and will be increasingly modified by it in the future is unquestionable. Whether, however, the live-stock industry in the South as a whole can be brought to a high degree of development, as is understood in more northern latitudes, is as yet problematical. "The easy optimism of those who assume that with the conquering of the tick an intensive system of animal husbandry can be established upon a basis of the methods followed in cooler climates is not shared by those familiar with the facts concerning animal parasites." The presence of other parasites potentially and actually as destructive as the tick constitutes a menace under which the industry cannot thrive and which, if disregarded, will surely and seriously impede the development of Southern agriculture. Unlike the tick these other parasites are mostly not peculiar to the South but range far to the northward. As a rule, however, in the north they do not limit the production of live stock greatly below the number that may be supported by the quantity of readily available feed stuffs. In the South, on the other hand, the capacity of the soil in the production of food for animals can be utilised to only a very slight extent, notwithstanding the eradication of the tick, unless measures are taken to eradicate or control other parasites as well.

Formerly on account of the relatively small numbers of live-stock and the small value set upon them generally the damage done by parasites or the damage they are capable of doing under Southern climatic conditions attracted comparatively little attention. Now, however, an emergency has arisen in the face of which the question of animal parasites in the Southern United States must be given serious consideration by the veterinary profession, and by all others interested in the welfare of the livestock industry. Already following upon tick eradication in many sections of the South evidence of serious trouble

from parasitic diseases among herds and flocks which have been increased in size is becoming apparent. Relief measures must therefore be promptly forthcoming if a severe set back for the movement for more and better live-stock in the South is to be avoided. Unfortunately, on account of our lack of knowledge concerning methods of controlling many of the parasites and owing to the lack of means of putting into effect the knowledge already available it is not likely that much headway will be made in the immediate future towards a practical solution of the problem. It is therefore anticipated that many of the ambitious plans for a rapid and extreme development of the livestock industry will come to grief, if not at the outset, at any rate, after a few years when stock has been introduced in considerable numbers into any area. A large margin should be maintained between the number of animals placed in a given area and the number that area will support judged by northern standards. Provision should be made for frequent movement to fresh grazing lands, the use of permanent pastures should be minimised, cultivated forage fields utilised as much as possible, and low-lying swampy areas avoided. Inasmuch as the parasites of horses, of pigs, and of ruminants, are in general not inter-transmissible these three kinds of animals may be grazed in turn upon the same fields with little risk of serious spread of parasitic diseases from one kind to another. It has also to be borne in mind that the dog is a necessary agent in the spread of a considerable number of more or less dangerous parasites of livestock, as well as of certain parasites of man, and that therefore the welfare of the animal industry and human welfare in the South as elsewhere demands the suppression of the wandering dog. Animals known to be seriously infested should not be pastured with others, but, generally it is useless to attempt to prevent the introduction of internal parasites. If not already present parasites of various kinds are almost certain to be introduced irrespective of any precautions that can possibly be adopted in practice. Hence, the animal industry amidst surroundings favourable to parasites must be conducted under the assumption that the parasites are always present and liable to cause great danger if given an opportunity. This opportunity may come with an unusually wet season or failure of the owner to preserve the precautions necessary for the control of parasites under the prevailing local conditions. The need for research into the control of parasitic diseases is therefore very strongly emphasised. As an indication of what the South [and any other country with similar climatic conditions] will have to contend with in the way of parasitic diseases attention is called to the following more important parasites.

Stomach worms of sheep and cattle, principally *Haemonchus contortus*. This is one of the most important parasites and the South has already suffered quite generally from it. More damage is anticipated with the advent of more cattle and sheep. As regards both curative and prophylactic treatment we are rather well supplied with information as to effective measures for dealing with these worms. The authors recommend the copper sulphate treatment and early treatment of infected animals and, having in mind the facts concerning the life history of the worm, a pasture rotation system applied to fenced-off areas of comparatively small size. [The reader is strongly advised

to consult the exhaustive work of VEGLIA upon this subject in South Africa, wherein effectual methods of both curative and prophylactic treatment are claimed to have been successfully obtained (this *Bulletin*, 1920, Vol. 8. No. 1. p. 26).]—ED.

Nodular worms (*Oesophagostomum* spp). These worms are of special interest on account of their frequency in sheep, cattle, and pigs in the South. Further, it is stated we are indebted to the South for some of our best studies of nodular disease, the bare-lot method of DALRYMPLE being one of the most interesting of the control measures used in connection with the nodular worm in sheep. The life history of these worms has never received adequate attention. The disease caused by them is spreading and increasing in extent and importance in the United States. As yet we have no demonstrable means of treatment for it. Experimentally, gasoline in doses of up to 1 oz. has been found to remove about 16 per cent. of the adult nodular worms, but this is not a satisfactory result, and gasoline has several objections.

Hook worms (Ankylostomum, Uncinaria spp.). The clinical effects of hook-worm disease in man and dogs are well known—numerous small intestinal haemorrhages with resulting persistent loss of blood, anaemia with resulting oedema, weakness, and emaciation. These worms are also sometimes very numerous in sheep and cattle, and many thousands were detected by the authors in one animal. In the South the condition caused by these worms in cattle is known under the name of "salt-sick" and is a troublesome disease. The parasites deserve considerably more investigation. They are difficult to remove from man and dogs, although oil of chenopodium or mixtures of this drug and chloroform used in certain ways may produce good results. In sheep and cattle the presence of the complicated ruminant stomach adds to the difficulty of treatment. As regards prophylaxis the measures which are of value against the stomach worm are also applicable to hook-worm disease, but in addition one must bear in mind the possibility, from what is known concerning the hook-worms of man and of the dog, that these parasites may enter their hosts through the skin so that even driving animals through infected sand or mud may result in infection.

Lung worms (*"Strongylus" micrurus, filaria, rufescens,* and *paradoxus*). These constitute another serious pest of cattle, sheep, and swine. The most reliable work of parasitologists apparently points to the conclusion that the lung worms have a simple life history, in spite of the contentions to the contrary of those who have claimed the need for an intermediate host or the alternation of a free-living stage with the parasitic stage. The embryos leave the lungs by way of the trachea, drop on to the pasture in the saliva or in the faeces, and then may develop into infective larvae, in the case of some species, in the course of a few days (10 days or less). Fumigation with various gases, intratracheal injections or injections up the nostrils of substances intended to kill the worms have been employed, but, in general, these treatments are attended with some degree of risk and their efficacy has in most cases not been proved. A treatment which seems worthy of trial on the grounds that it is simple, comparatively safe, and apparently of value in improving the condition of animals treated, is the one recommended by HERMS and FREEBORN, consisting in the injection of chloroform into the nostrils with a medicine dropper,

giving sheep 3 c.c., pigs 5 c.c., and calves 11 c.c. The nostrils are closed with the fingers until the animal shows signs of collapsing. The treatment is applied once or twice at five-day intervals, if necessary. It is recommended that Epsom or Glauber salts be administered two hours after treatment. Good nursing, placing the animals on an uninfected pasture, and good feeding are recommended in order to improve the animals' constitution until the worms die off.

Ascarids, or maw worms. These are of importance in the South, but generally they are regarded as more serious intestinal parasites of pigs, horses, and dogs than of cattle and sheep. In some cases at least the larval forms in the lungs may do considerable injury even where they do not complete their development and appear as mature worms in the intestine.

It had been generally supposed that the eggs were passed in the faeces and an infective embryo developed in the egg and that when these eggs were swallowed by suitable host animals the embryo was released in the digestive tract and there developed into the adult worm. It is now known that when the infective eggs are swallowed by the host the embryos hatch in the intestine, make their way to the lungs, probably in the blood stream, and reach a certain stage of development in the air passages of the lungs. They then ascend the trachea and are swallowed ; subsequently if the infested animal be a suitable host they become mature in the intestine. It has also been found that when the eggs are swallowed by some animal other than the normal host, as when the eggs of the pig ascarid are swallowed by the rat, the embryos will escape and travel to the lungs, undergoing development to a point where they will ascend the trachea and travel down the oesophagus. Further development, however, does not take place and the larvae are passed out of the body in the faeces.

It seems quite likely that there is no specific ascarid of the sheep as these worms are apparently too rare in sheep to keep any particular species in existence if it depended entirely or principally on this host. It is practically certain, according to the authors, that these worms are the pig ascarids in an unusual host. They are poorly adapted to living in sheep and are usually immature forms, smaller than the pig ascarid. It appears likely that sheep must swallow infected ascarid eggs quite frequently, that the embryos may often travel to the lungs, and that very few of the resulting larvae ever develop in the intestine. If this view is correct one should sometimes find cases of verminous infection of the lungs in sheep caused by young ascarids.

In young pigs the lung lesions caused by ascarids may complicate diagnosis in suspected swine fever (or so-called swine plague). The lesions take the form of characteristic bright red haemorrhagic points due to larval ascarids and heavy infections are capable of killing animals. These larval worms have been found associated with the group of symptoms in pigs known as " thumps," a condition usually attributed to some nervous disorder, and characterised by pulmonary and cardiac disorder when the pigs were exercised or excited especially when the stomach was full. The pigs lost flesh, became stunted, and had poor appetites. Turning animals out to pasture was found beneficial. It now seems that this disease is often associated with ascarid infection, the worms being responsible for the poor condition and lack of growth as well as for the pulmonary symptoms.

Ascariasis in the dog may be successfully treated with American worm-seed oil (oil of chenopodium), the product of a plant common in the South, in doses of 0·1 c.c. per kilogramme body weight with 1 oz. castor oil; in pigs, with doses of 4 c.c. per 100 lbs. live weight with 2-4 ozs. castor oil. It may be successfully treated in the horse with carbon bisulphide in single six drachm doses, two 4 drachm doses at a 2 hour interval, or in three 3 drachm doses at hourly intervals. The worms are too rare in the intestines of sheep and cattle to require treatment. Prophylaxis resolves itself into sanitation, clean stables and pens, clean food and water, and pasture rotation when necessary.

Strongyles (of the genera Strongylus, Triodontophorus, Gyalocephalus, and Cylicostomum. These are of first-rate importance in the horse. Mixed infestations give rise to a general clinical picture complicated in separate cases by certain features characteristic of the individual species of worms. The general picture is one of an afebrile condition, unthriftiness (indicated by a rough coat and poor condition), and disturbances of digestion such as diarrhoea or constipation. This general picture is apt to be associated with anaemia as a result of the blood-sucking habits of such worms as Strongylus, a condition which in turn is naturally associated with oedema and ascites. Further complications of a very different kind are furnished by the larvae and agamic forms of the species *Strongylus vulgaris*. So far as is known all these strongyles have a direct life history; the eggs in the manure undergo a development that gives rise to an infective larval stage on pasture. When the larvae are ingested by equines they take different routes in the body and undergo somewhat different lines of development, depending on the species involved. The larvae of *S. vulgaris*, for example, make their way to the posterior mesenteric artery or sometimes other branches of the posterior aorta and set up the well-known parasitic aneurisms, which are a source of potential danger on account of their liability to produce emboli.

On post-mortem examination a number of striking lesions are readily found. The mucous membrane of the caecum and large colon quite commonly presents numerous petechial haemorrhages resulting from the attacks of the worms belonging to the genus Strongylus (*S. equinus*, *edentatus*, and *vulgaris*) and these worms are quite commonly found attached to the mucous membrane, though some are found free, usually near the mucous membrane rather than deep in the ingesta. Ransom and HADWEN noted that ulcers found in the posterior loop of the colon are due to *Triodontophorus tenuicollis*, the worms being commonly found attached in a cluster to these ulcers. The same condition was described by HARTMAN although he did not determine the species of worm responsible for the ulcers. Numerous small worms of microscopic size may be found in the mucous membrane (worms belonging to the genus Cylicostomum) and cysts in the wall of the large intestines occasionally contain agamic forms of *S. vulgaris*, presumably returning to the intestine to complete their development. Larval and agamic forms of Strongylus may be found in various places, *S. equinus* showing a preference for the liver, lungs, and pancreas, and *S. edentatus* occurring in various places under the pleura and peritoneum in the hepatic ligament, the perirenal connective tissue, the muscles of the forearm, and even, perhaps in the aorta. The last-mentioned species exhibits a predilection for occurring in the cryptorchid testis. Strongylidosis

appears to be amenable to treatment to an extent that would at first sight hardly seem likely. Experimental evidence indicates that the strongyles of the large intestine may be very readily removed by fasting an animal for 36 hours and administering 16–20 c.c. (4–5 drachms) of oil of American worm-seed (chenopodium) immediately preceded or followed by a quart of linseed oil. Fairly good results may be obtained by the substitution of 2 ozs. turpentine for the worm-seed oil.

For horses out at pasture it would probably be advisable to administer such a treatment twice a year, since it is certain that the animals will be always more or less heavily infested.

A comparison of the degree of strongyle infestation of horses in Michigan and in Virginia indicates that infestations are much greater as a rule in Virginia, which is what would naturally be expected from the difference in temperature, the rainfall, and the moisture factor near Detroit, and that near Washington being very nearly the same. Horses throughout the South, it is stated, are likely to show a greater number of these worms on an average than those of the North.

Habronema. Species of this genus of nematode parasites of the horse have of late years been found to be important. [See preceding extracts, p. 198 *et sqq.*] As regards treatment no adequate tests of anthelmintics for these worms in the stomach of the horse have yet been made, but American worm-seed oil would probably be effective against *H. muscae* and *H. microstomum*; carbon bisulphide is a very penetrating, highly solvent, and quite toxic substance exerting its maximum effect in the stomach and on theoretical grounds therefore it ought to be tested against the ulcer-forming *H. megastoma.* In summer sores early and complete ablation of the diseased skin appears to be the best treatment. Prophylaxis is summed up in manure control and fly control. There are a number of ways in which manure may be handled so as to prevent fly spreading and one of these ways should be used. The maggot trap, which is essentially a platform for manure built over water is one of these devices, and the burial of fresh manure daily under the old manure to cause over-heating to a temperature unfavourable to maggot development is another. The fly-tight manure bin is a device often mentioned but experience shows that there are few of these bins that are actually fly-tight. Removing manure promptly to the fields and spreading it in a thin layer so as to facilitate drying is an efficient measure when it is practicable.

In the Southern States conditions favour the development of Habronema. The climate is ideal for the development of the house-fly and the stable-fly, and labour and other conditions interfere with the general adoption of methods for more sanitary methods of handling manure and raising horses.

For some years a disease called leeches or leeching has existed in Florida. From the available evidence it appears likely that this disease is a cutaneous habronemiasis.

Liver flukes. These are important parasitic pests in the Southern States. Both the common liver fluke of sheep, occasionally present in cattle [*Fasciola* (*Distomum*) *hepatica*], and the large liver fluke [*Fasciola* (*Distomum*) *gigantea*] of cattle occasionally present in sheep are widely distributed in the South along the Gulf Coast and back along the river valleys opening on the Coast. It is a matter of interest that although certain species of snails have been shown to act as

intermediate hosts in other countries the snail which functions as the intermediate host of the liver fluke in the United States has never been determined [see in this connection abstract of PORTER'S important work in South Africa, p. 206]. As regards treatment French authorities advise the administration of oleoresin of male fern to sheep in doses of 3-5 grammes, according to the size of the sheep, in 10 c.c. of a non-purgative oil, 2 hours before feeding in the morning, on five successive mornings, using male fern with a content of at least 24 per cent. filicine and 3·5 per cent. filicic acid. The dose for cattle is 12–25 grammes according to the size of the animal. Hungarian authorities recommend the administration of powdered kamala in amounts of 15 grammes given in from 1 to 5 doses ; strong animals may be given the entire amount at one dose ; animals in general are given it in two doses at a 12–24 hour interval, and weak animals are given the treatment in five doses. The dose for cattle is 0·139 to 0·26 grammes per kilogramme of live weight.

Nothing whatever is known as to the intermediate host of the large liver fluke although it is presumably a snail [see also, however, p. 207]. This parasite seems to be more pathogenic for sheep although of more common occurrence in cattle. No treatment for this fluke has yet been evolved.

Prophylaxis in the case of both flukes is evidently a matter of keeping sheep off wet pasture and since much of the pasture of the South is of this sort attention should be directed to draining such pastures where practicable. If there is only a small amount of such pasture on a farm it should be fenced off from sheep as dangerous, and used for grazing cattle and horses and not for sheep or young animals of any sort. Dressings of lime and salt in June, July, and August to kill embryos and larvae of flukes and to kill and repel snails are recommended. Sheep on salt marshes are said never to become infected. It is advisable to treat infested flukes at the beginning of the winter after the danger from fresh infestation is passed.

Miscellaneous parasites. Tape-worms of sheep and cattle now appear to be by no means unimportant parasites ; nothing is known with regard to their life histories and therefore no suitable prophylaxis can be formulated.

The screw-worm fly is now a cause of serious losses ; the wool maggot-fly has caused much loss in Australia, and may become equally important in the Southern States. The authors dwell upon the great importance of the prompt disposal of carcases. Ox warble control is another field for investigation.

BACTERIAL DISEASES.

BOQUET (A.). **Contribution à l'étude de la Lymphangite Ulcéreuse des Solipèdes.** [Ulcerative Lymphangitis of Equidae.]—*Rev. Vétérinaire.* 1920. Jan.-Mar. Vol. 72. Nos. 1–3. pp. 10–19, 78–90, & 137–145.

These notes on ulcerative lymphangitis were written in 1918 at the request of Professor SENDRAIL, the Director of the Military Veterinary

Research Centre of the French Army. The experiments and observations recorded in this study are in reality complementary to those presented in NOCARD's memoir on the disease in 1896, and they are to be taken in conjunction with the researches on the pathogenesis and therapy of the equine lymphangites conducted at the Military Research Centre, at the Alfort School, by BOSSAVY under the inspiration of Professor VALLÉE.

While the experiments were as yet not complete some of the results were collected and published at the request of the Veterinary Authorities at the Ministry of War [this *Bulletin*, 1919. Vol. 7. No. 4. p. 224]. The investigations which are now closed make it necessary to add a few more concise details to the already recorded results. After giving a number of details upon the bacteriology, etiology, symptomatology and diagnosis of the condition the author describes a number of experiments performed with the object of acquiring more precise information upon the pathogenicity of the causal organism, immunity, and treatment.

The disease is stated to be characterised by the successive development in the subcutaneous cellular tissue, most frequently of the limbs, of a series of abscesses due to the action of the Preisz-Nocard bacillus. Special attention was paid to the question whether this organism was the actual and only cause of the disease inasmuch as experienced workers such as BRIDRÉ and TRUCHE had asserted that the ulcerative lymphangites observed during the War were not all due to the action of the bacillus and that a fairly considerable number were due to some other cause. Boquet, however, concludes that if this bacillus does not exist in the living state in every case of the disease then the purulent contents of the lesions possess no pathogenic property. Under the influence of the diffused toxic product of the organisms the subcutaneous connective tissue undergoes a fibrous change resulting in elephantiasis in the affected limbs. FAYET'S (1917) statistics with regard to the distribution of the lesions in 1,188 cases are of interest : left hind limb 493, right hind limb 512, left fore-arm 10, right fore-arm 9, both hind limbs 119, non-localised 45.

The disease is therefore said to be essentially local and chronic and the experiments proved that the causal organisms penetrate through or into the skin subsequent to the formation of erosions, caused in particular by the irritant effect of mud contaminated with excreta. The organisms multiply slowly and may remain latent for several weeks, during which time their presence is manifested only by a progressive sclerosis of the connective tissue. Under the effect of certain influences, as yet undetermined, these centres then enter into a state of activity and undergo suppuration. The overlying skin becomes necrosed and ulcers are formed. The particular train of symptoms associated with the disease, its mode of development and extension are the resultant effects imposed by the nature of the tissues invaded, viz., the dense connective tissue at the extremity of the limbs, the blood and lymph supply of the parts, and especially the mobility of the affected region, which favours the gradual extension of the lesions. Whatever may be the degree of virulence of the particular strain of Preisz-Nocard bacillus its diffusibility is feeble and localised ; its spread is effected exclusively by way of the lymphatics. When the organism gets transported along the course of a lymphatic vessel of some considerable

size it sets up at some distance away from its original nidus large suppurating lesions which develop as acute phlegmonous swellings and then heal, but in the great majority of cases the protective barrier of the lymphatic glands is not traversed in this process. Exceptionally however, the organism breaks through into the blood stream and sets up in a number of locations, but most frequently in the kidney, suppurating lesions which may bring about a fatal termination to the disease in the affected animal.

The disease shows no tendency towards recovery except when the sources of re-infection are suppressed by the imposition of suitable hygienic conditions and the maintenance of the affected animals at rest. The regression of the lesions and the complete destruction of the organisms in the foci of disease are then favoured by the aid of specific forms of treatment. The methods of treatment which gained favour during the war were the surgical method, and the newer methods of pyotherapy and bacteriotherapy. HAAN and AUGER rightly insist upon the early opening of the abscesses and SENDRAIL'S experience likewise led him to advise the same method for epizootic and ulcerative lymphangitis. The chief advocates of pyotherapy were BELIN, Van SACEGHEM, and BRIDRÉ; of bacteriotherapy, TRUCHE, WATSON, and KNOWLES.

Dealing with the question of bacteriotherapy the author states that focal reactions of an identical character to those produced after the use of vaccines made from the specific organism were set up in affected animals following upon the injections of non-pathogenic yeasts (*Saccharomyces cerevisiae*). Injections of 1 c.c., 2 c.c., 5 c.c., 10 c.c., 30 c.c., in successively increasing doses practised every seven or eight days provoked during the first four weeks an inflammatory reawakening of the lesions. The swelling of the limbs increased and fresh abscesses opened. During the following weeks the suppuration diminished and the ulcers cicatrised. Recovery was then brought about but with the same degree of slowness and the same variations in its progress as in the case of control horses, simply kept at rest. A certain number of horses were treated by BOSSAVY with the toxin of the bacillus; apparent recovery was brought about after a short interval, but a few relapses were observed.

Treatment by so-called haemotherapy, or iso- and auto-haemotherapy, was employed. Four horses were injected subcutaneously with their own blood in increasing doses of from 40–60 c.c. every 2–4 days for six weeks. The degree of improvement observed as the result of this treatment was neither more rapid nor more distinct than in the case of untreated horses. MIDDELDORF, who tried this treatment in 1918 on the German front, asserted that he had obtained some truly remarkable recoveries following upon its use. Three or four days after an injection of 50 c.c. of blood the discharge from the ulcers disappeared and the swellings diminished in size. Out of 14 cases treated 13 were reported to have recovered in from six to seven weeks. Specific serotherapy had been tried by VALLÉE (1907), HAAN and AUGER (1917), and WATSON. HAAN and AUGER employed the serum of horses naturally recovered or convalescent after the disease, anti-diphtheria, and anti-streptococcus serum. None of these appeared to possess any curative value. WATSON employed injections of serum alone obtained from horses hyper-immunised against the Preisz-Nocard

bacillus, or mixtures of virus and serum, or used the method of serotherapy in conjunction with bacteriotherapy. Very little of a conclusive character could be deduced from his results. Bacilli sensitised according to BESREDKA'S method likewise did not prove efficacious in his hands.

As mentioned above Boquet concludes from observations made by him in concert with SENDRAIL and BOSSAVY that absolute rest in the stable constitutes the best form of treatment for ulcerative lymphangitis. It is above all through the effect of the rest imposed upon patients treated with the numerous chemical and biological medicaments that they have given the results adjudged excellent by those experimental workers who devised them. Rest should be as complete as possible, the patient should not leave the stable except to be exposed to the sun during the most suitable hours. Surgical interference such as puncturing of the abscesses and deep cauterisation favours speedy evacuation of the pus and limits the extent of the lesions, but the curative action of these forms of treatment is somewhat illusory.

The ulcers should be treated by douching with weak antiseptic solutions every three or four days and the application of slightly irritant or caustic agents, such as tincture of iodine or the mixture recommended by LANNELONGUE in the treatment of scrofulous adenitis:

Oil	75	grammes.
Ether	25	„
Creosote	5	„
Iodoform	10	„

General treatment should take the form of bacteriotherapy according to TRUCHE'S method [this *Bulletin*, 1917. Vol. 5. No. 3. p. 187] or toxinotherapy according to VALLÉE and BOSSAVY'S method. These forms of treatment should be prolonged for at least two or three weeks after the cicatrisation of the ulcers, especially where there are marked signs of elephantiasis. The patients should be suitably fed and maintained in perfect hygienic conditions, in paved, frequently disinfected, commodious and well aerated stables. When the disease is progressing favourably towards recovery as manifested by cicatrisation of the ulcers and regression of the fibrous thickenings the animals are able to withstand light work on dry ground without ill-effect.

As regards prophylaxis there is fortunately not much risk of the disease propagating under conditions of peace as it did, with serious consequences, among Army horses in the War. The disease is, in fact, only very slightly contagious in well kept stables. When isolated cases of the disease occur the patients should be separated from other animals and the stalls, harness, and the instruments used for dressing them should be disinfected in boiling water or with an antiseptic. The mallein test enables one to differentiate the condition quickly from glanders and microscopic examination will eliminate epizootic lymphangitis, a much more contagious and serious disease. The animals should then be submitted to one of the forms of treatment mentioned above and after recovery and the absence of relapse for six weeks to two months they can be put back in the stable.

WATSON (E. A.). **Ulcerative Lymphangitis or "Preisz-Nocard Disease" of Horses, with Especial Reference to Immune Sera, Toxin, and Anti-toxin.**—*Jl. American Vet. Med. Assoc.* 1920. June. Vol. 57. (New Series Vol. 10.) No. 3. pp. 257–269.

A series of investigations was conducted by Watson while attached to the Royal Army Veterinary Corps in France and also in part since his return to the Veterinary Research Laboratory, Department of Agriculture, Lethbridge, Canada.

Thirty horses were used in experiments to ascertain the infectivity and period of incubation of the disease. Twenty of these were placed in contact with 20 horses presenting typical open ulcers, for 48 hours. Only one of the 20 animals subsequently developed the disease, in 17 days, and this horse had received a kick from another animal during the 48 hours contact. Six horses were selected showing slight skin injuries and these injuries were smeared with infected pus. Only one horse subsequently developed a lesion, in 25 days. Slight wounds were made artificially with the point of a scalpel in four of the horses and immediately rubbed over with infected pus; infection resulted in three horses, in 7, 14, and 24 days respectively. The period elapsing between the first appearance of lesions and the formation of multiple ulcers from a chronic thickening of a limb is very uncertain and irregular. The disease may evolve rapidly but more often it is a slow insidious recurrent process.

The wide variation in virulence of different strains of Preisz-Nocard bacilli was illustrated by their effects after inoculation into guinea-pigs. Whereas small doses of cultures injected intraperitoneally resulted in death in some under 24 hours, in marked orchitis in others on about the 4th day, slight orchitis and death in others in 6–7 weeks, several strains, sub-cultivated for many months in the laboratory, became quite avirulent for guinea-pigs. Inoculations into horses also showed that the virulence of the bacilli was of a very unstable character.

An attempt to confer an immunity (both anti-bacterial and antitoxic) towards the Preisz-Nocard bacillus was made with a view to obtaining a serum that might be successful in the treatment of the disease. Three horses were utilised and the material inoculated consisted of whole cultures treated by heat or chemical solutions, the toxic filtrates of unaltered cultures, and virulent bacilli. The method of dosing and intervals between the injections were approximately the same for all three horses. The experiment covered a period of 470 days and was divided into three stages, viz., (1) attempted immunisation (1–195 days); two horses succumbed after this stage, (2) further immunisation (210–350 days), (3) immunity and anaphylaxis (402–465 days). At the end of the first stage a serum was obtained from the horses which inhibited the growth of the bacillus in culture and protected the guinea-pig against fatal doses of toxin. Nevertheless, the horses furnishing this serum were themselves unable to resist the intravenous injection of a large dose of virulent culture, which caused a generalised infection in all three animals and fatal results in two of them. In the second stage the surviving horse recovered normal health and condition under a course of treatment with sensitised vaccine and furnished a serum antitoxic

and to some extent anti-bacterial in action. This serum seemed to have a marked effect upon horses suffering from the disease, the local lesions healing up rapidly; nevertheless after some weeks relapses were apt to occur with this form of treatment—as with any other form tried. In the third stage an attempt was made to raise the degree of immunity, and especially the anti-bacterial rather than the antitoxic immunity. Killed or altered bacilli, only, treated with alcohol-ether mixture and dried in vacuo as prepared by TRUCHE were employed as antigen. Following upon a number of injections and several blood lettings an anaphylactic state was suddenly encountered in which there was apparently manifested the sudden activity of the Preisz-Nocard infection that must have been dormant for at least six months. The infection then developed in a remarkable manner; the bacilli invading the blood stream caused in it an intense leucocytosis, but in no part of the body exercised their habitual and characteristic local action of pus formation except in the bloodless fluids of the eyes. Instead of being chronic the disease was very acute and produced a rapid septicaemia, intoxication, and death. No such cases appear to have been hitherto recorded.

A number of experiments were made in order to determine the anti-bacterial and anti-toxic actions of the serum obtained from the above immunised horses. It was found that in spite of its marked inhibitory action upon the specific organisms in vitro the serum exerted but little influence upon their virulence in vivo, only retarding their pathogenicity for a day or two as determined by test inoculations upon guinea-pigs. No satisfactory method of performing the agglutination test upon the bacilli could be devised owing to their tendency to clump automatically.

Experiments showed that, (a) 1 c.c. of toxin, obtained from filtered cultures of the organism kills a guinea-pig within 24 hours, (b) 1 c.c. of toxin added to 1 c.c. of normal horse serum also kills a guinea-pig within 24 hours, (c) 1 c.c. of toxin added to 1 c.c. of the anti-serum is neutralised or fixed and remains inoffensive for the guinea-pig. Samples of anti-serum evaporated to dryness and kept in powder form for 18 months or two years were still found to retain this antitoxic property. The serum of horses clinically attacked with the disease was also found to have specific anti-toxic properties. This fact underlies a method which Watson devised for the diagnosis of the disease. A lethal dose of the toxin is added to a neutralising dose of the suspected serum and after 20 minutes contact injected into a guinea-pig. A negative reaction indicates Preisz-Nocard infection in the animal furnishing the serum. This method is successful in determining latent forms of the disease and is now employed upon Army horses returning to Canada from France.

There does not appear to be "any real relationship between the Preisz-Nocard bacillus and *Bacillus diphtheriae*" of man, but it is admitted that there are "striking analogies and the toxins, antitoxins, and the cultural characters of these microbes seem to have many points in common."

A number of experiments were made upon the properties of the toxin produced by the Preisz-Nocard bacillus. While, as mentioned before, some strains are virulent and others non-virulent some produce an active toxin and others do not. Strains for experiment were selected

that had a highly toxic effect upon guinea-pigs. The toxin was prepared by growing the organism in massive cultures on the surface of broth, and afterwards filtering the growth. On heating at 50–60° C. for one hour the filtrate had no toxic effect upon guinea-pigs, at 55–58° C. it caused a local oedema, unheated it caused death in 24–36 hours. By filtration through very fine Chamberland candles a considerable part of the toxin was lost. Carbolic acid or cresol, 0·4 per cent., seemed to cause a rapid deterioration of the toxin, whereas brilliant green 1 in 50,000 to 1 in 100,000 acted as a good preservative. The rabbit also proved very susceptible, death occurring four hours after the injection of 2 c.c. Only a few preliminary observations have been made on its action upon horses. Subcutaneous injection into normal horses caused a local swelling to appear after 24 hours attaining its maximum dimensions in 48 hours. In immunised and in diseased horses a similar local swelling occurred, but in 12–18 hours, and became reduced in size in 24 hours, and disappeared completely in 48 hours. The observations are admitted to be too few to admit of any conclusion. Horses clinically affected with the disease become immunised to the toxin, their serum having a decided anti-toxic action, but nevertheless the disease continues to make progress. Immunity to the toxin therefore does not carry with it immunity towards the virulence of the bacilli themselves, which continue to exercise a pathogenic power even in the presence of antitoxin.

SHEATHER (A. L.). **The Virulence of Tubercle Bacilli Isolated from Bovine Lesions in India.**—*Jl. Comp. Path. & Therap.*, 1920. June 30. Vol. 33. No. 2. pp. 73–103.

Tuberculosis in cattle in India appears to be rare and in many Provinces the disease has not hitherto been recorded [this *Bulletin*, 1919, Vol. 7, No. 4. p. 265]. In recent years, however, evidence has been obtained indicating that it is by no means uncommon, especially in slaughterhouse cattle, in some parts. TAYLOR (G.) in the course of systematic inspections at the Ferozepore slaughterhouses, Southern Punjab, found that about 3 per cent. of the animals actually slaughtered had tuberculous lesions, and this figure would probably have been considerably higher if the number of cattle—amounting to 18 per cent.—rejected on account of their poor condition before slaughter, had been taken into account. The lesions in the affected cattle were, however, almost invariably of a localised nature and confined to the thoracic cavity [this *Bulletin*, 1918, Vol. 6, No. 2. p. 112].

In 1917 LISTON (W. Glen) and SOPARKAR (M. B.) published the results of experimental work in which they endeavoured to ascertain the susceptibility of Indian milch cattle to tuberculosis [*Ibid*, p. 110]. These authors inoculated a number of buffalo and cow calves from four to eight months old with a strain of European bovine virus, such as was used by the English Royal Commission on Tuberculosis,—in doses of 10 and 50 mg. subcutaneously. Whilst the experiments of the Royal

Commission showed that English calves almost invariably died of acute tuberculosis when inoculated with 50 mg. of this virus the authors' experiments proved that at least 50 per cent. of the Indian calves lived for many days after having been similarly inoculated, and when killed showed only retrogressive or healing tuberculous lesions. They hold that their work confirms the general experience that Indian cattle are less commonly affected with tuberculosis than English cattle are and supports the view that the comparative infrequency of the disease among cattle in India is due to a natural resistance rather than to any particular method of housing or keeping cattle.

In the course of the present paper Sheather gives a careful description of a series of experiments carried out at the Imperial Bacteriological Laboratories at Muktesar along somewhat parallel lines to those performed by LISTON and SOPARKAR using, however, a strain of bovine virus isolated from native naturally-occurring cases for testing the susceptibility of buffalo and hill calves. The original material utilised for the investigation was obtained from some specimens sent by TAYLOR for examination. The lesions in eight of the slaughter-house cases of which descriptions are given were confined to the chest cavity and were of a localised nature. The number of bacilli in the lesions varied considerably but they were recognisable on microscopic examination in all but one case.

The material from 16 cases was used for the inoculation of small animals. Leaving out of consideration the laboratory animals that died accidentally or were proved to have been inoculated with organisms that were apparently dead the results were as follows: The duration of life in the guinea-pigs inoculated subcutaneously ranged from 89 to 217 days (10 guinea-pigs), and in those inoculated intraperitoneally from 73 to 183 days (11 guinea-pigs). The figures given by the English Royal Commission, after inoculation of guinea-pigs with emulsions of tuberculous tissues of European bovine origin, were 27 to 146, and 8 to 140 days, respectively, which would indicate that tubercle bacilli of Indian origin are distinctly less virulent than those of European origin.

Cultures of the Indian virus are stated, generally speaking, to possess the usual characters of bovine bacilli and are distinctly dysgonic. After sub-cultivation upon egg and upon serum-agar for some generations a few strains were induced to grow upon the surface of glycerine broth. The growth was very slow and at its maximum extent took the form of islands measuring about 1 inch in diameter. A strain, isolated from a single case, that gave about the best growth upon broth was used for the inoculation of buffalo and bull calves. The 10th generation of this strain was induced to grow upon broth and after about six months incubation the growth was emulsified in 0·4 per cent. salt solution. Three suspensions of different strengths were made containing 5 mg., 1 mg., and ·01 mg., respectively per c.c. The weaker emulsions were used for tests upon rabbits. The Royal Commission found that rabbits inoculated intravenously with ·1 mg. of culture (of European virus) invariably died of generalised tuberculosis within 34 days, the average period being 21 days. Sheather's

rabbits (2 done with ·1, and 2 with ·01 mg.) survived about twice this length of time, indicating that the strain used was of a lower virulence.

Thirteen plains bull calves and 11 plains buffalo calves from 8 to 12 months old and obtained from the Bareilly District were utilised for the test. The temperature of these animals was taken regularly for about six weeks before being used for experiment, and three days before the virulent inoculation they were tested with tuberculin (3 c.c. subcutaneously and ·25 c.c. concentrated intra-palpebrally) to exclude natural tuberculosis. Two buffaloes showed an irregular temperature, in one case due to trypanosomiasis and in the other to some unknown cause. All were concluded to be free from tuberculosis.

"The value of the ophthalmic and intra-dermal palpebral tests is practically nil, at least so far as concerns plains buffaloes brought to the hills as they are extremely liable to catarrhal conjunctivitis at all times." In the case of this test any discharge present was ignored as the uninjected eyes varied very considerably from hour to hour during the test.

The buffaloes and calves were each divided into two groups so that individuals in the groups were respectively as nearly as possible pairs as far as their weight was concerned. The odd buffalo and calf were kept as controls. One group of buffaloes and one group of calves were then injected subcutaneously on the left side of the neck with emulsion of tubercle bacilli, dose 10 mg., the other groups were injected in the same way with 50 mg.

Subsequently the experimental animals were tested at intervals (indicated in the accompanying chart) with tuberculin both subcutaneously and intradermally, either by injection into an anal fold or into the skin of a lower eyelid. A rise of 2° F. above the temperature at the time of injection of the tuberculin was taken to constitute a reaction. All the infected buffaloes and all but four of the infected bull calves gave a temperature reaction a month after the virulent inoculation, and a striking feature was the extraordinary marked local reactions which developed at the seat of injection of the subcutaneous dose of tuberculin on the side of the neck in some of the animals. These bore a very close resemblance to the local reactions produced by mallein. Difficulty was experienced in appraising the value of the intradermal tests, but more marked reactions were shown by practically every one of the infected animals than by the controls. The eye reactions were considered to be all negative.

Sheather also discusses the anomalous results obtained in the temperature reactions particularly in the course of the second tuberculin test. None of the animals died and all in fact showed a decided increase in weight during the course of the experiment.

With a view to rendering the experiment comparable to that carried out by Liston it was decided to kill off all the animals as quickly as possible after the completion of the fifth month, and make a careful post-mortem examination of each animal. The results are given in the composite table on the next page.

TABLE I.

Animal.	Age.	Weight.	Inoculation. 11:10:19	Tuberculin Tests. 10–11–19	11–12–19	9–2–20	16–2–20	23–2–20	1–3–20	8–3–20	Gain in Weight.	Post-mortem findings.
Buffalo 215	1 year	210 lb.	10 mg., sub-cut	+	+	+	..	..	..	+	95 lb.	Slight tuberculosis.
,, 217	,,	255 ,,	10 ,, ,,	+	+	+	+	..	..	..	145 ,,	,, ,,
,, 219	,,	260 ,,	10 ,, ,,	+	—	+	..	+	..	..	70 ,,	Generalised but not progressive.
,, 222	,,	300 ,,	10 ,, ,,	+	+	+	..	..	+	..	110 ,,	Slight tuberculosis.
,, 220	,,	330 ,,	10 ,, ,,	+	+	+	..	+	..	..	162 ,,	,, ,,
,, 223	,,	225 ,,	50 ,, ,,	+	—	—	..	..	—	..	63 ,,	Generalised but not progressive.
,, 224	,,	255 ,,	50 ,, ,,	+	—	+	..	..	+	..	160 ,,	Slight tuberculosis.
,, 218	,,	270 ,,	50 ,, ,,	+	—	—	..	..	..	—	100 ,,	Generalised but not progressive.
,, 216	,,	280 ,,	50 ,, ,,	+	—	+	+	..	..	..	140 ,,	Slight tuberculosis.
,, 227	,,	315 ,,	50 ,, ,,	+	—	—	..	..	..	+	145 ,,	Extensive but not severe.
,, 221 (Control)	,,	238 ,,	Not inoculated	—	—	—	—	—	—	—	162 ,,	Healthy.
Bullcalf 9	10 mths.	140 ,,	10 mg. sub-cut	—	—	+	..	+	..	..	80 ,,	Extensive but not severe.
,, 3	8 ,,	152 ,,	10 ,, ,,	—	+	—	..	..	..	—	108 ,,	Slight tuberculosis.
,, 1	1 year	170 ,,	10 ,, ,,	+	—	—	..	..	..	—	65 ,,	,, ,,
,, 2	,,	235 ,,	10 ,, ,,	+	—	+	+	..	..	..	145 ,,	,, ,,
,, 6	,,	245 ,,	10 ,, ,,	+	—	+	..	—	..	..	145 ,,	,, ,,
,, 5	,,	275 ,,	10 ,, ,,	+	—	+	+	..	..	..	175 ,,	,, ,,
,, 13	,,	140 ,,	50 ,, ,,	+	—	—	..	..	..	—	40 ,,	,, ,,
,, 4	,,	160 ,,	50 ,, ,,	+	—	+	+	..	..	..	95 ,,	,, ,,
,, 11	,,	200 ,,	50 ,, ,,	—	—	—	..	..	—	..	110 ,,	Generalised but not progressive.
,, 8	,,	220 ,,	50 ,, ,,	+	—	—	..	+	..	..	75 ,,	Extensive but not severe.
,, 10	,,	245 ,,	50 ,, ,,	+	—	+	..	..	—	..	115 ,,	Slight tuberculosis.
,, 12	,,	310 ,,	50 ,, ,,	—	—	+	..	..	—	..	145 ,,	Generalised but not progressive.
,, 7 (Control)	,,	360 ,,	Not inoculated	—	—	—	—	—	—	—	130 ,,	Healthy.

The significance of the terms used under the heading post-mortem findings is as follows :—

"(a) Slight tuberculosis. A lesion at the seat of inoculation, lesions in the thoracic glands and possibly the abdominal glands, a few lesions in the lungs or spleen.

"(b) Extensive, but not severe. As the above, but with the addition of tuberculous pleurisy or peritonitis or both. No cases of extensive tuberculosis of a severe nature were found.

"(c) Generalised, but not progressive Cases in which there was evidence of invasion of the organs by way of the blood stream, with the production of numerous lesions in the lungs."

The Royal Commission, as stated before, found that the subcutaneous injection of 50 mg. almost invariably produced fatal generalised tuberculosis within seven weeks. When the dose was 10 mg. a similar result was produced in 60 per cent. in eight weeks. In Sheather's experiments six of the buffaloes showed slight tuberculosis, one showed

Table II.

Animal.	Dose.	Gain or loss of weight.	Killed or died.	Duration of life.	Post-mortem Findings.
Buffalo 1	50 mg.	+109 lbs.	K	142 days	Retrogressive tuberculosis.
„ 2	50 „	— 18 „	D	22 „	Broncho-pneumonia.
„ 3	50 „	+146 „	K	125 „	Retrogressive tuberculosis.
„ 4	50 „	+ 88 „	K	128 „	„ „
„ 5	50 „	— 30 „	D	67 „	Acute general tuberculosis.
„ 6	50 „	— 17 „	D	101 „	„ „ „
„ 7	10 „	— 4 „	K	107 „	Retrogressive tuberculosis.
„ 8	10 „	— 11 „	D	39 „	Broncho-pneumonia.
„ 9	10 „	Not weighed	D	3 „	Other causes.
„ 10	10 „	+ 58 lbs.	K	133 „	Retrogressive tuberculosis.
„ 11	10 „	Not recorded	D	9 „	Other causes.
„ 12	Not	inoculated.	Died	from other	causes.
„ 13	„	„	„	„ „	„
Calf 14	50 mg.	—641 lbs.	K	142 days	Retrogressive tuberculosis.
„ 15	50 „	— 8 „	K	122 „	„ „
„ 16	50 „	— 23 „	D	43 „	Acute general tuberculosis.
„ 17	50 „	+ 3 „	K	122 „	Retrogressive tuberculosis.
„ 18	50 „	— 20 „	D	39 „	Acute general tuberculosis.
„ 19	50 „	— 6 „	D	38 „	„ „ „
„ 20	10 „	+ 30 „	K	133 „	Retrogressive tuberculosis.
„ 21	10 „	+ 28 „	K	128 „	„ „
„ 22	10 „	— 19 „	D	37 „	Acute general tuberculosis.
„ 23	10 „	+ 43 „	K	135 „	Retrogressive tuberculosis.
„ 24	10 „	— 7 „	D	34 „	Acute general tuberculosis.
„ 25	10 „	— 12 „	D	79 „	„ „ „
„ 26 (Control)	—	+ 51 „	..	..	Control not inoculated.

extensive, but not severe infection, and three showed generalised but not progressive disease. Four out of the five to which 10 mg. of culture were given showed slight disease. The remaining ones showed generalised disease. Of the bull calves eight showed slight tuberculosis, two extensive, and two generalised infection. Of the six inoculated with 10 mg. five showed slight invasion and one extensive

disease. The lesions found in buffaloes affected with generalised tuberculosis were somewhat more marked than in the calves similarly infected.

Assuming that the susceptibility of plains buffaloes and cattle in the United Provinces is similar to that possessed by animals in the Bombay Presidency Sheather concludes that a comparison of the results obtained by him with those obtained by LISTON indicates that Indian strains of tubercle bacilli isolated from cattle are far less virulent than European bovine strains. The composite table indicating in brief LISTON'S results is reproduced on the preceding page.

It is highly improbable that the strain used by Sheather was of particularly low virulence in view of the comparative effects produced in guinea-pigs after the inoculation of a number of strains.

LISTON'S experiments indicate that Indian cattle are less susceptible to infection with the tubercle bacillus than English animals when tested with a virus of European origin. Sheather's experiments indicate that this is not the sole and possibly not even the most important factor in determining the comparatively infrequent occurrence of tuberculosis in Indian cattle. The strains of tubercle bacilli infecting cattle in India undoubtedly possess a distinctly lower degree of virulence than tubercle bacilli isolated from cattle in Europe.

[A point which is not perhaps without some possible significance is that the experimental animals used by Sheather were considerably older than those used by LISTON, and that the latter's "buffalo calves" were in a weakly condition at the time of inoculation. The results obtained are thus not strictly comparable, as fatal results would in any event be more likely to be obtained in LISTON'S animals.—Ed.]

HORNBY (H. E.). **A Contagious Impetigo of Cattle.**—*Vet. Jl.* 1920. June. Vol. 76. No. 6. pp. 210–216. With 2 text-figs.

Skin diseases are of the greatest importance next to the trypanosomiases as the source of losses to European cattle owners in the Fort Jameson district of Northern Rhodesia. The most serious form of skin disease is demodectic mange, but the condition which forms the subject of this article is nearly equally important. Other forms of skin disease affecting cattle in Northern Rhodesia are psoroptic mange, eczema, and a dermatitis of white skinned animals which is probably due to the action of strong sunlight on sensitised unpigmented skin [see, however, this *Bulletin*, DODD, Trefoil dermatitis p. 259].

In 1915 Van SACEGHEM in the Belgian Congo described the etiology of the so-called contagious impetigo of cattle [this *Bulletin*, 1917. Vol. 5. No. 2. p. 108] and what is probably the same disease has been discussed by ARMFIELD 1916, CURSON 1919, and HUTCHINS 1919, LANE, Chief Veterinary Officer, Northern Rhodesia, described it in a circular letter in 1915.

The disease is said to occur throughout Central Africa,—in North Western Rhodesia under the name of Senkobo skin disease (LANE), in the New Langenburg district of the Tanganyika Concession as Saria (CURSON). It is also believed to exist in British East Africa (McCALL, F. J.) and Egypt (Van RAES). A streptothrix infection in a dairy herd at Kampala, Uganda, described by HUTCHINS is also believed to be

identical. The author observed cases in Northern Rhodesia, Nyasaland, Portuguese East Africa, and Tanganyika Concession (formerly German East Africa). Its distribution recalls that of demodectic mange, for like that disease it is apparently unknown to stockowners south of the Zambesi.

The condition affects primarily cattle, although LANE claims to have known an eland to contract the disease, and lesions seen on the legs and sheath of a horse seem to the author somewhat reminiscent of contagious impetigo. It is enzootic throughout Central Africa and native cattle are often seen slightly affected. European cattle and their so-called grade progeny are far more susceptible than are native cattle, and among them the disease may assume an epizootic form. The disease shows no predilection as regards age or condition.

The disease is essentially seasonal in character and fresh cases are seen at the commencement of the rainy season, while after the termination of the rains the disease assumes a chronic form in survivors and fresh cases do not occur. Lesions occur on any part of the body but as a rule they are first noticed on the back where matting together of a few hairs ("paint brushes") may be seen. Later, there are slight elevations on the skin, which grow and become confluent until bare wart-like scabs are formed penetrated by a few hairs. These scabs are easily removed leaving a moist pink surface, and very rarely there is an appreciable amount of pus. The lesions may be confined to the back and in a native animal they remain inconsiderable in extent or even disappear spontaneously. If the disease makes its appearance on a more susceptible animal immediately before the cessation of the rains it may remain in the form of a localised lesion. Otherwise, when such an animal is attacked earlier in the rainy season the lesions commencing on the back spread progressively to the sides, perineum, axillae, udder or scrotum, belly, thighs, shanks, neck and head; the formerly discrete patches now become confluent, the animal loses condition, and eventually dies emaciated.

LANE describes two forms of the disease, viz., one similar to the above and the other characterised by small lumps under the skin followed later by wart-like growths. HORNBY thinks it probable that the latter cases are ones of mixed infection with the impetigo parasite and demodectic acari. Van SACEGHEM considers that from the clinical point of view the disease may be localised or generalised.

Early in his studies the author became convinced that the condition was not an acariasis and later he had no difficulty in finding the parasite described by Van SACEGHEM.

The streptothrix can be detected in stained smears from the serous exudate found under the crusts or more simply from particles of the crust teased out after a few minutes immersion in normal saline solution. The stains recommended are the ordinary basic aniline dyes and Giemsa. This parasite, claimed by Van SACEGHEM to be the true cause of the disease and named by him *Dermatophilus congolensis*, does not grow deeply into the skin, and the hair is never attacked. It is suggested that the reason why the disease assumes a grave character only during the rains is because the conditions of humidity and warmth necessary for its growth are only to be found at this period of the year. Sucking calves frequently develop lesions around those parts of the muzzle which are regularly moistened with milk. Propagation takes

place through the medium of infected rubbing places, contaminated litter or trek gear, and perhaps also through the agency of whips and flies.

Diagnosis after a very little experience is easy, as the scab formation is very characteristic. To demonstrate the parasite the crust is pulled off and the exposed raw surface scraped with a clean knife. A somewhat thick smear is made of this sanguinous matter and after fixation with heat stained with alkaline methylene blue. It is on the thicker parts of the preparation that one finds masses of the parasites. Among the scattered cells of the thin parts one finds only small pieces of broken mycelium. Hornby believes that its thickness certainly exceeds 1·8μ, given in Van Saceghem's description. Extraneous bacteria are surprisingly rare in the smears.

Prophylaxis is very difficult on account of the impossibility of detecting minute lesions on a native, or immune, beast, and thus preventing the introduction of the disease. Regular dipping in an arsenical fluid is claimed by some to act as a preventative but a number of Southern Rhodesian oxen brought to Fort Jameson in 1919 contracted the disease through intermediate infection in spite of regular fortnightly dippings in full-strength arsenical fluid. Lane claims that regular dipping in full-strength Cooper's dip will cure mild cases. For more advanced cases he recommends a lime and sulphur bath. Van Saceghem insists that treated animals should be kept dry if possible, and in his opinion the lesions should not be washed or subjected to friction as he considers that these manipulations only irritate the skin and serve to spread the lesions. He states that he caused generalisation of previously localised lesions by friction during the application of arsenite of soda solution. He recommends causterising local lesions after carefully picking off the crusts. His best results in the treatment of generalised cases followed the application without friction of carbolised pomade, dressing only a quarter of the body surface at one time. Piot Bey recommends washing with soap, raising the crusts, and then painting the infected surface with a 1 per cent. solution of picric acid.

Arsenical dip as a curative agent was not satisfactory in the author's hands and a dressing of paraffin, sulphur, and lard was likewise unsuccessful. He agrees with Van Saceghem that a therapeutic agent which fails to kill the parasite may serve to spread the disease and the application of weak carbolic acid did in fact lead to untoward results in this manner. It is useless to attempt treatment with disinfectants of ordinary wound lotion strength ; for instance, mercuric perchloride is only successful when employed in the strength of 1 in 200. The author dresses his cases with Cooper's milk oil fluid in a solution not weaker than 1 in 30. Strong emulsions of similar proprietary drugs, such as Hycol, Izal, Jeyes' Fluid, etc., are likewise successful. In treating a solitary lesion the crust is picked off and the undiluted milk oil fluid applied. When the lesions are localised the fluid is used in the strength of 1 in 10, or 1 in 20. When the disease is generalised so that the whole body must be dressed the fluid is used in the strength of 1 in 30, but only from a quarter to one half of the animals' body depending upon the extent of raw surfaces exposed by removing the scabs, is dressed at one time. By this means the author claims to cure all but the worst cases, especially if a fortnight after the first dressing all unhealed lesions receive a second and stronger application of the medicament.

MAGALHAES (O.). **Ensaios de Mycelogia. (2. Nota previa.)** [Experiments in Mycology.] *Brazil-Medico*, 1920. July 3. Vol. 34. No. 27. p. 431.

In this preliminary note the results of some experiments upon the therapeutic action of the iodides in mycotic disease are published. The action of these drugs in the human or animal body invaded by certain moulds still remains without a rational interpretation. The experiments of DE BEURMANN and GOUGEROT (1912) indicated that their action upon sporothrix organisms is not analogous to that produced, for example, by " 606 " upon spirochaetes inasmuch as they do not seem to act in virtue of a direct microbicidal action. [See also experiments by DAVIS on sporotrichosis in rats. This author concluded that the iodides acted by stimulating tissue reaction rather than by a direct anti-sporothrix action, for the organisms were found capable of growing readily in media containing a high proportion of iodides in solution (this *Bulletin*, 1919, Vol. 7, No. 4, p. 236.]

Magalhaes experimented with a Brazilian pathogenic mould *Oidium brasiliense* (which causes oidiomycosis in man). A number of tests showed that the iodides did not retard the development of this mould in cultures even when they were present in considerable quantity. On the other hand, in the living body they appear to have a remarkable action upon the mould.

Rabbits hyper-immunised against the parasite were found to contain amboceptors in their blood. A distinctly positive intradermal reaction could, moreover, be produced in affected rabbits even when they only harboured very small lesions produced by attenuated cultures. The ophthalmic reaction was always negative in the rabbits as it is in man.

The serum of rabbits hyper-immunised against the mould (by 17 subcutaneous inoculations of a rich emulsion of mixed strains of dead organisms) was tested against cultures. This serum gave a distinctly positive result to the complement test. It, however, did not retard the development of the mould *in vitro*, even when very large quantities of it were employed. Also, serum from rabbits inoculated over a prolonged period with solutions of potassium and sodium iodides (10 c.c. of an isotonic solution every three days until 10 or 12 injections had been given) did not exert any inhibitory influence upon the growth of cultures *in vitro*. The serum of normal rabbits, moreover, did not prevent development.

Treatment with iodides, on the other hand, in cases of pulmonary oidiomycosis, caused the lesion and the mould gradually to disappear and simultaneously the clinical condition of the patients improved. The iodides would appear therefore to exert an action upon *O. brasiliense* similar to that displayed against sporothrix.

DISEASES DUE TO FILTERABLE VIRUSES.

PANISSET (L.) & DISCHAMPS (A.). **Inoculation du virus rabique dans le torrent circulatoire du cobaye.** [Inoculation of the Rabic Virus into the Circulating Blood of the Guinea-Pig.]—*C. R. Soc. Biol.* 1920. June 26. Vol. 83. No. 22. pp. 983–984.

Since GALTIER described the effects of inoculating saliva from rabid animals into the circulating blood of herbivora numerous workers

have resumed the study of this problem. GALTIER'S results have never been invalidated but subsequent experiments have shown that the phenomenon is irregular in its manifestation. All workers have noted that the effects of inoculating the virus into the blood varied, depending upon the animal species and even upon the channel of entry of the virus (arteries or veins or even particular veins).

Panisset and Dischamps introduced fixed virus directly into the blood by intracardiac inoculation of guinea pigs. The fresh brain material was carefully macerated, weighed, and suspended in normal saline solution, in the proportion of one gram of brain matter to 10 c.c. of liquid. This emulsion after having been filtered through linen was finally diluted down to 1/100, 1/1,000, 1/10,000 and 1/100,000 times its original strength ; the dose employed was 1 c.c. All guinea pigs inoculated with quantities varying from 1 centigram to 1/100 of a milligram succumbed to rabies (except when they died sooner as the result of accident), after an interval of from 12 to 13 days. It would thus appear that in the guinea pig intracardiac inoculation of the rabies virus reproduces the disease.

CURASSON. **Sur l'immunisation par la bile dans la peste bovine.** [Immunisation by means of Bile in Rinderpest].—*Bull. Soc. Cent. Méd. Vét.* 1920. May 20. *Rec. Méd. Vét.* 1920. Apr. 30,-May 30. Vol. 96. Nos. 8 & 10. pp. 142–145.

Although this old method of immunisation has now been abandoned in nearly all countries, the author employed it on a large scale in dealing with the outbreaks of rinderpest which recently raged in French West Africa. The author admits that in inoculating bile an animal is infected in the same manner as if it were injected with any of the body fluids of the subject affected with the disease. If the bile utilised for infection is obtained from animals that have shown acute symptoms of the disease, in a herd in which the mortality rate is high such as occurs at the commencement of an outbreak, then the vaccinated animals die with the same symptoms and in the same proportions. If, on the other hand, the liquid is obtained from animals slightly affected with the disease or at the end of an outbreak the results as a rule give one the impression that the method is a good one.

The author's observations upon the method were made in several districts in the French Soudan throughout the whole course of the outbreak, which at its onset produced high fatalities but towards its end killed only small proportions of the animals. For example : In July and August 1917 in the district surrounding Kayes which had been infected for several months the mortality remained fairly steady at between 25 and 30 per cent. A few herds had remained unaffected. These were artificially contaminated with infected milk or urine or injected with glycerinated or carbolised bile ; the mortality rate produced thereby was the same in all the herds and analogous to that in the naturally infected villages.

In the same district but on the other side of the river the minimum mortality rate in several large herds was 60 per cent. In two neighbouring villages bile obtained from one of these infected villages was injected, with 70 per cent. losses. A neighbouring herd artificially contaminated lost 60 per cent. of its animals.

A herd situated at some distance from these villages in the same district suffered a mortality of 86·2 per cent. ; bile obtained from it and injected into a clean herd in another village produced a mortality of 75·6 per cent., and a neighbouring herd artificially contaminated lost 78·7 per cent. A herd near by in which the disease had broken out naturally lost 68·5 per cent.

In the Nioro district out of 940 animals belonging to one village the natural onset of the disease killed 308, or 33 per cent. In this village a herd which had remained unaffected was infected with bile, with 28 per cent. loss. In a neighbouring village artificial contamination with virus obtained from the last-mentioned source produced 35 per cent. loss.

The above examples are said to be only a few of very many of the kind which came under the author's observation. In a village in the Bafoukale district the mortality amounted to only 20 per cent, as it did also in all the surrounding region. Bile obtained from this village was glycerinated and carbolised and used five days later for the injection of two herds that had remained unaffected in the Kayes district 150 kilos. distant. In the villages round about these two herds the mortality rate varied from 70 to 80 per cent. 26 per cent. of the animals in these two herds succumbed ; on the same day animals belonging to a neighbouring herd were injected with bile obtained from cattle in the district, with 80 per cent. mortality as a result.

Since the author made his observations in 1917 and the beginning of 1918 the various veterinary inspectors engaged in the French Soudan and Senegal have obtained the same results with bile and have drawn the same conclusions. However, LAGAILLARDE, who worked upon infected and non-infected herds in Senegal concluded that the method gave good results and ought to be employed in an infected region, where a supply of serum is not at hand. This worker's opinion was undoubtedly based upon the fact that he obtained bile from herds in which the virulence of the disease had become attenuated.

It might be concluded that if one were to use some discretion in selecting bile producers one might be able to convey a slightly virulent form of the disease to animals inoculated. This is obviously, however, not always possible since it is the herds around those already infected that one has to operate upon, and consequently one is obliged to utilise the bile as it is available on the spot. Moreover, this form of inoculation has all the disadvantages which are adherent to artificial contamination, viz., extension of the infected area, creation of new centres of disease and a bad impression upon the native owners.

MONFRAIS. **Note sur la durée de l'immunité acquise par une première atteinte de peste bovine.** [Duration of the Immunity acquired after passing through one attack of Rinderpest.]—*Rec. Méd. Vét.* 1920. Apr. 15–May 15. Vol. 96. Nos. 7 & 9. pp. 224–225.

The author's observations were made in the course of the outbreak of rinderpest in French Senegal from 1917 to 1919. In a certain region the disease re-appeared in May and June 1919, although in April 1917, i.e., more than two years previously all the herds in this part had become infected, with a single exception. In the case of this particular herd that had not been infected in 1917 all the cattle (85 head) became

infected with the disease and 34 died, that is, 40 per cent. On the other hand the cattle belonging to the neighbouring herds that had been infected in 1917, and were given every facility, by being brought to the same drinking wells, to become contaminated in 1919 became affected only in the proportion of 20 out of 126, and only 6 died, i.e., a total mortality of 3·9 per cent. A strong immunity was therefore acquired by the first attack.

A point of interest is that the whole of the yearling and two year old bullocks and heifers, born since the first outbreak, became infected, and nearly half of them died (5 out of 11 head), while 8 per cent. only of the adults were attacked and all of the adults that showed symptoms recovered.

However, calves born during the year and still sucking did not show any signs of the disease, indicating that they maintained for some time at least the immunity they had acquired from their dams.

SCHEIN (H.). **Vaccination contre la peste bovine.** [Vaccination against Rinderpest.]—*Bull. Soc. Path. Exot.*, 1920. May. Vol. 13. No. 5. pp. 338–342.

In the preceding number of this *Bulletin* [p. 152], reference was made to some experiments carried out by CROVERI (P.) in Italian Somaliland, the results of which would seem to negative the claim made formerly by Schein that 1/1000 c.c. of virulent blood is sufficient to set up an active immunity in the course of sero-vaccination against rinderpest. Schein maintains that the Italian author's results are not valid inasmuch as no control animals were utilised in the experiments. If instead of inoculating the minute dose into all four calves he had given two this dose, and the other two 1 c.c. of undiluted blood simultaneously, and then submitted them all subsequently to a test inoculation a better comparison could have been made. The virus moreover, was taken from an animal on the 5th day of disease; Schein believes that the best result is obtained after an interval of seven days from the time of injection. On the 5th day the virus may not be sufficiently abundant in the blood. Other factors have to be taken into consideration—for example, well known variations in the activity of the virus in the course of an outbreak, and the probable resistance of Somali cattle to infection. For the test inoculation it would also have been better to re-vaccinate only two of the animals, and infect the other two, respectively, with ½ c.c. and 1/1000 c.c. of virus without serum.

Schein's experience in French Indo-China indicated that the injection of 1/1000 c.c. invariably produced a fatal result; BOYNTON in the Philippines, likewise transmitted the disease with 1/3000 c.c.; TURNER, found 1/1000 c.c. capable of killing an adult ox. Moreover, when serum alone was utilised for dealing with outbreaks in the Annamese villages the disease invariably reappeared, with full virulence, after a month's interval. On the other hand sero-vaccination practised accord to Schein's method put an end to fatalities in all except animals that were in the incubation period at the time of inoculation. Some further examples are given of the efficacy of the method.

It is thus concluded that 1/1000 c.c. of virulent blood injected simultaneously with anti-serum is sufficient, at all events in the case of Indo-China cattle, to provoke a quite manifest reaction, resulting in the production of a stable active immunity; owing to the hyper-susceptibility of the buffalo this procedure can be adopted with comparative safety, for the resulting accidental mortality is fairly low.

Niles (W. B.) & Rietz (J. H.). **Duration of Immunity against Hog Cholera following Simultaneous Inoculation of Young Pigs.**—*Jl. American. Vet. Med. Assoc.*, 1920. May. Vol. 57. (New Series Vol. 10.) No. 2. pp. 176–182.

It has been frequently stated that in a large percentage of cases the simultaneous inoculation of young pigs does not confer a lasting immunity against swine-fever. The minimum age at which the operation can be carried out so as to ensure lasting immunity has been stated by various authors to be any time from weaning time up to the time they attain 50 or 60 lbs. in weight. A series of twelve experiments were carried out by Niles and Rietz of the U.S. Bureau of Animal Industry in order to elucidate this point.

All the pigs used in the first nine experiments were farrowed at the Bureau Station grounds at Ames, Iowa, and during the interval between farrowing and exposure, they were kept in small pastures as far away from the buildings and experimental pens as possible. Drainage was as far as possible arranged so as to be directed away from the pasture; care was taken to avoid contamination of the feeder and care-taker, and every other necessary precaution was observed to avoid contamination of the pigs between immunisation and exposure to the virus. In the last three experiments carried out on the farms in the vicinity of Ames, Iowa, the pigs were allowed to run about at liberty inasmuch as there was no history of infection on these farms.

No apparent ill effects were produced by the simultaneous inoculation in any of the pigs or non-immune sows used in the experiments. The serum was injected in equal amounts into the two inguinal and axillary spaces of each pig, the virus being injected into the buttocks. The 171 pigs inoculated on the station premises and on farms, when they were seven days to six weeks old, and exposed to swine fever infection after an interval extending from five months to nine months and 26 days, were found without exception to be immune to swine fever. Three of these pigs, however, died during the period of exposure from causes other than swine-fever. There was no difference in the degree of immunity in pigs from immune and from non-immune sows.

These experiments would appear to indicate that the simultaneous inoculation of young pigs confers a lasting immunity.

[Compare the opposite results claimed to have been obtained by Croveri (this *Bulletin* 1919. Vol. 7. No. 2. p. 95.) in the case of simultaneous inoculation of calves against rinderpest.—Ed.].

Jouan (C.) & Staub (A.). **Étude sur la Peste Aviaire.** [Fowl Plague, a Study.]—*Ann. Inst. Pasteur.* 1920. May. Vol. 34. No. 5. pp. 343–357.

The researches recorded in this paper were interrupted by the war, since when it has not been possible for the authors to obtain a supply

of virus. Recent work upon this disease up to the year 1916 has contributed the following further information :—

The fowl, pheasant, parakeet, and Java sparrow, are susceptible; geese, at first held to be refractory, have been successfully inoculated when under the age of six months; adult geese also succumb when inoculated sub-durally; a virus was then found in a goose which killed even old geese by subcutaneous inoculation. An outbreak has been recorded among wild ducks (*A. germana*), but here, the brain alone appeared to be virulent, the blood was not infective; the disease was not transmissible to the domestic duck, which hitherto has proved refractory.

The filterability of the virus through Berkefeld and Chamberland candles has been confirmed by all authors when the source has been either blood, crushed brain material, or intestinal contents. The virus has even been successfully filtered through Bechhold's ultra-filter No. 5, which holds back haemoglobin; the dimensions of the virus would accordingly be about 2·4 millionths of a millimetre. One ten millionth of a c.c. of virulent blood is sufficient to produce death by subcutaneous inoculation and even smaller quantities have been used. The virus has been found to reside, in the fowl, in the blood and all the organs, as well as the intestinal contents; in the young goose, in the blood during the first three days after inoculation, and in the brain; in the adult goose (over six months old), in the brain only; nevertheless the virus which is capable of killing the adult goose by subcutaneous inoculation is present in the blood. The question as to whether the virus multiplies only in the interior of the red corpuscles or whether it resides indifferently in the corpuscles or in the plasma has not yet been resolved. However it is generally recognised that the corpuscles are much richer than the serum in the virus. This might be attributed to a simple fixation of the virus to the corpuscles. Indeed, by adding fresh corpuscles to a virulent serum, it is deprived of a part of its virulence, which is taken up by the added corpuscles.

Several authors believe that the virus is in the nature of a protozoon, basing their contentions : (1) on the resistance of the virus in glycerine, by analogy with what takes place, in rabies, vaccinia, and syphilis; (2) on the action of saponin (in 1 per cent. solution) which when mixed with the virus prevents infection. Saponin, it is stated, has no action upon bacteria, whilst it, on the other hand, renders trypanosomes immotile; (3) on the fact that the virus after having been present in the blood of young inoculated geese, and then having disappeared, may again reappear in the blood; this is analagous with what takes place in human malaria. In the brain of infected birds formations similar in appearance to Negri bodies have been described. Finally, on examining the clot obtained by centrifuging the filtrate obtained by passing an extract of brain through a bacterial filter small paired points have been seen, after staining by Loeffler's method for flagella.

Some authors maintain that the virus can be destroyed by heating for five minutes to 60° C; others maintain that it resists 70° C, but is killed at 80° C., whilst others claim that the virus residing within the brain resists a temperature of 65–80° C. for four hours, whilst liver extract is inactivated after half an hour at 60° C.

There is no definite information as to how the contagion is propagated. Infection *per os* failed, as did also attempts to transmit by the agency

of argasid ticks; thus some authors have refused to admit that the disease is contagious.

Hitherto attempts to vaccinate by means of heated virus have failed. The fowl has been successfully vaccinated, however, by injection with brain material from an infected young goose after allowing it to dry in a vessel containing caustic potash.

The serum of a fowl recovered from the disease destroys the virus in vitro and is capable of protecting a susceptible fowl against infection. Sheep after inoculation with the virus furnish a serum which is slightly potent.

On the ordinary media, including Noguchi's medium, attempts at culture have always failed. However, the virus has been kept alive for 10 generations in defibrinated fowl blood overlying a clot composed of peptonised agar containing glucose.

Some experiments were performed first by Jouan and Staub which confirmed those of previous authors with regard to the extreme infectivity of the disease by inoculation of the filtered virus. The strain used was avirulent for the adult goose and duck but virulent for the Java sparrow. The pigeon also proved to be susceptible; after several attempts the virus was sub-inoculated four times, commencing with a young pigeon three to four weeks old and ending up with an adult pigeon; nervous symptoms of progressingly increasing intensity were manifested from the fourth day onwards.

It was found quite easy to transmit the disease to the fowl *per os* by mixing the virus with the food and introducing it within the oesophagus.

After heating for 24 hours at 44° C. the virus was not killed although it became less active. After two days at 46°, three days at 47°, or ¾ hour at 55°, the virus was not killed, but after one hour at 55° or 10 minutes at 60° it was destroyed. It was then found possible to vaccinate fowls by means of killed virus, obtained by keeping the virulent blood at 46–47° C. for three days, the dose employed being about 10 c.c. intramuscularly. The vaccination thus performed set up a very considerable degree of resistance towards infection. Numerous tests then showed that the serum obtained by hyperimmunising these fowls with large doses of virulent blood was no more effective than that obtained from a bird that had been simply vaccinated, either by inoculation with heated virus, followed by a test inoculation with heated blood, or as a result of sero-vaccination. The best method of obtaining an active serum was by inoculating the fowls intravenously. The goose did not appear to produce a satisfactory serum.

The serum thus prepared from the fowl was bactericidal in its effects. Animals inoculated with a mixture of serum and virulent blood, kept in contact for a quarter of an hour, suffered no ill effects but succumbed to an inoculation with virulent material ten days afterwards.

Attempts were made to obtain a sensitised virus. Serum heated at 56° C for half an hour, however, destroyed the virus with which it was mixed, and did not vaccinate. An attempt was then made to eliminate the complement contained in the virulent blood by adding washed rabbit corpuscles, which are haemolysed by means of normal fowl serum. Fowl serum loses all its complement after treating it with about half its volume of the washed rabbit corpuscles. The

virus thus treated was mixed with serum, heated to 56°C from a hyper-immunised fowl, and after having been kept in contact for 24 hours at 33°C the mixture was used as a vaccine.

It was found possible beyond doubt to vaccinate by this method but hitherto the method has resulted in the loss of a certain number of the animals. These losses did not appear to depend upon the amount of serum in the mixture or upon the doses of vaccine employed, but rather upon the probability that the virus may remain in some of the corpuscles without becoming affected, or it may be insufficiently impregnated with the serum. In other experiments, however, the blood was laked in order to render the mixture homogeneous, without obtaining better results. The vaccination obtainable by means of this method would appear to depend upon a modification of the virus and not upon a simultaneous immunisation with serum and vaccine, inasmuch as fowls inoculated simultaneously, but at different points with serum and with virus succumbed, but after a slightly longer interval than in the case of fowls injected with virus alone. Moreover, the protection afforded was not due to the effects of a serum alone, for it was found after 14 days the effect of the serum disappears completely.

Serum inoculated 24 hours prior to the injection of the virus affords complete protection and enables one to vaccinate the fowl with safety.

All attempts at cultivation of the virus remained fruitless on ordinary or special media. Nevertheless a definite multiplication appeared to take place in the yolk of egg. Yolk from an egg taken from the oviduct of a fowl inoculated with the disease proved virulent and retained its virulence for over three weeks when kept at laboratory temperature. It was not found possible to sub-cultivate the virus in yolk medium kept in test tubes, but success was achieved by inoculating fertilised eggs that had been kept a certain time in the incubator. The yolk sac was inoculated directly, with sterile precautions, by means of a fine pipette. Control eggs injected in this way with normal saline solution eventually hatched out normal chicks. Six successive generations of virus were, however, carried on by this method, the last of which still killed a Java sparrow within 48 hour . There thus appeared to be no loss of virulence ; subsequently attempts at sub inoculation remained fruitless. The positive results are not believed to be attributable to traces of the original virus ultimately remaining in the eggs, but rather to the fact that it is necessary for the eggs to undergo a certain amount of development before they are inoculated. Eggs which had only been incubated one day did not prove virulent, whilst the results observed were obtained with eggs incubated for at least three days.

VAN HEELSBERGEN (T.). **Beitrag zur Kenntnis der Geflügelpocken, insbesondere mit Bezug auf ihre Verwandtschaft mit der Vogeldiphtherie, der Stomatitis pustulosa contagiosa equi und der Vakzine.** [Fowl Pox, with Special Reference to its Relationship with Fowl Diphtheria, Stomatitis pustulosa contagiosa equi, and Vaccinia (Cow-pox).]—*Cent. f. Bakt.* 1. Abt. Orig. 1920. Apr. 24. Vol. 84. No. 4. pp. 288–303.

Recently there has been a tendency, especially in German literature, to consider fowl-pox as identical with fowl-diphtheria. This

assumption is based principally upon the researches of CARNWATH, UHLENHUTH, MANTEUFEL, VON RATZ, and VON BETEGH. Some preliminary experiments confirmed the accuracy of this view. Five fowls were inoculated intravenously and on to the comb with diphtheritic material; one only developed a very slight lesion on the comb; when material from these lesions was, however, sub-inoculated by application to the comb of another fowl a well-marked fowl-pox eruption was observed and later a typical diphtheritic membrane developed on the buccal mucous membrane. In the great majority of cases the author believes that the fowl-pox virus is the cause of fowl-diphtheria.

The existence of a fowl-diphtheria as a separate morbid entity with a separate specific cause, such as, for example, the Klebs-Loeffler bacillus, or, very probably the micrococcus of BORDET and FALLY can at the present state of our knowledge, however, not be disregarded.

The virulence of the causal agent and the morbid manifestations set up by it varied considerably both in natural and experimentally produced infections, a point which has already been noted by other authors. The virus was proved again to belong to the class of filterable viruses, as stated originally by MARX and STICKER; others have however, claimed that the virus is not ultravisible but consists of rather distinct coccoid bodies stainable by Giemsa and from 0·3 to 0·6μ in diameter.

Rabbit bile is known to have a destructive effect upon the mammalian-pox viruses while usually the bacteria are comparatively resistant towards this substance. Van Heelsbergen proved, moreover, that the fowl pox virus was completely destroyed after 10 hours contact with the bile. In his experiments the virus was found to pass not only through a Berkfeld filter but also through the Chamberland B and F types of bacterial filter.

The author next describes a series of interesting experiments upon the transmissibility of fowl-pox to mammals. A number of rabbits were inoculated and cutaneous reactions were produced which were exactly analogous to those set up after inoculation with cow-pox virus. The eruptions usually became confluent but isolated vesicles developed in some of the transmission experiments.

The next point of importance was to determine whether the fowl-pox virus could set up an eruption in calves. Two calves were thus inoculated by rubbing the virus into scarified patches on their bellies in the same manner as is employed in the production of cow-pox lymph. Four days afterwards a slight but typical reaction was produced and about 2 grammes of lymph were obtained from the vesicles of each calf. The reactions produced by the fowl-pox and the cow-pox viruses in calves therefore would appear to be identical, and this would suggest a close relationship between the two viruses.

A cow was subsequently inoculated with fowl-pox virus by rubbing the material into the side of the neck, which had previously been shaved, and partly rubbed with sandpaper and partly scarified. Six days afterwards a distinct vesicular eruption was observed, and the blebs were seen not only along the course of the lines of scarification but also in enormous numbers about 40 cm. away from them. The reaction was characterised by a marked infiltration of the infected area and pain, and healing was rather slow. The affection ran its course in three weeks; the general condition of the animal was not disturbed.

Experiments were next performed in order to determine the effect of cow-pox virus upon fowls. This virus was inoculated on the combs of several fowls. A typical pox-like eruption invariably followed, which represented a specific reaction inasmuch as a similar appearance could not be produced with any other micro-organism. Several control experiments were performed, always with negative results. The pox-like eruptions showed a great tendency to suppurate, as also is the case usually in fowl-pox lesions. In some cases of natural fowl-pox, however, the lesions were very similar to those produced by the cow-pox virus in fowls. No visible reaction was manifested after injection of the cow-pox virus intravenously into the fowl. The inoculation was only effective when performed on to the comb, and an immunity was thereby produced against the fowl-pox virus. Again, on the ground that the fowl-pox and cow-pox viruses produced similar morbid appearances in fowls the author concludes that they must be very closely related.

A pigeon was received for examination affected with naturally occurring fowl-pox, and two fowls were inoculated on to the comb with material from this pigeon. A few days later a typical pox-like eruption developed which was exactly similar to that produced after infection with cow-pox in these birds, and comprising discrete suppurating pustules, which quickly dried up and then persisted in the form of fairly large warts for some time. A reaction such as this is therefore stated to be obtainable (1) with cow-pox virus, (2) with pigeon-pox virus (the pigeon virus is identical with the fowl virus), (3) with fowl virus that has been kept for a long time in 50 per cent. glycerine in an ice-chest. It would thus appear that the reaction could be provoked by any one of these viruses provided it had become for any reason only slightly virulent for the fowl.

Experiments were then performed in order to ascertain whether the virulence of the fowl-pox virus could be exalted as the result of passage through the rabbit. It is known that cow-pox virus is usually rendered more virulent for the calf by transmission through rabbits. One calf was scarified in the usual manner and infected with fowl-pox virus that had been passed once only through a rabbit. Five days afterwards a distinct vesicular reaction was manifested, the blebs being situated both on and between the scarified lines, and about 1 gramme of lymph was obtainable.

Another calf was infected in like manner with fowl-pox material which had been passed three times through rabbits, but had originated from the same source. Four days afterwards a marked reaction was observed, the vesicles being ranged in rows along the lines of scarification and in large numbers between them. Vesicles and typical pustules were produced and 16 grammes of pure lymph were collected.

A month later the fowl-pox virus, which had been preserved, was found to be of such low virulence that no reaction was produced in four infected calves. However, after passing this virus three times through rabbits it again regained its virulence so that several calves were successfully infected. It had thus to be concluded that the fowl-pox virus could be rendered more highly virulent for the calf by passage through rabbits.

A young ox was then infected by rubbing fowl-pox material into a carified area on its neck; the material had been passed four times

through rabbits. After a few days a very distinct pox-like reaction was observed. Material was taken from the pocks and applied to the right side of the abdominal wall of a calf. The left side of the belly was infected with the material that had been applied to the young ox, that is, with fowl-pox material which had been passed only four times through rabbits. After a few days the calf showed on both sides a typical reaction but the reaction on the right side was, however, much less marked than that on the left. The difference was manifested principally in the smaller number of pocks, a slighter infiltration, and the much more rapid drying up of the eruption. The entire picture clearly indicated that the virulence of the fowl-pox virus had been exalted by passage through the ox.

Experiments were next performed in order to study the immunity reactions produced by the cow-pox and fowl-pox viruses. Five fowls were infected on the comb with cow-pox virus. After a few days all these birds showed a distinct vesicular reaction, from which they quickly recovered. Fourteen days after the inoculation all had recovered completely, and 12 days subsequently they were next infected with fowl-pox material on to the comb, while five healthy control fowls were likewise infected with the same material. In the case of both the cow-pox infected birds and the control birds, a vesicular eruption appeared on the comb, but there was an enormous difference between the course of the disease in the two lots. All the cow-pox fowls exhibited an abortive reaction, that is, the pocks commenced to dry up in three days and in ten days all the animals had completely recovered. The control fowls became ill for a week and showed marked wasting, while two of them succumbed to the disease. Infection with cow-pox virus would appear, therefore, to set up an immunity towards the fowl-pox virus.

Proof that the immunity produced was not merely due to the after-effect of a simple inflammatory reaction set up as the result of the nitial cow-pox inoculation was obtained by the following experiment. Five fowls with well developed combs were infected with cow-pox virus. The right side of the comb was first cleansed with a little water and the virus was applied to it lightly by means of a small wad of cotton wool so that there was no haemorrhage and no pronounced irritation. All birds developed after an incubation period extending over a few days a typical cow-pox eruption on the right side of the comb ; the left side, however, remained quite healthy. An interval of one month was allowed to elapse after complete recovery, when the combs became normal and smooth. Fowl-pox virus was then applied to the left side of the combs while, simultaneously, five control fowls were similarly infected with this virus. The five controls developed a marked eruption on their combs and remained for a long time very ill, while, on the other hand, the fowls that had been treated with cow-pox manifested no symptom of disease. A *local* immunity had thus been set up by the cow-pox virus.

It would appear, however, that a general immunity against fowl-pox infection could not be set up in fowls by an inoculation with cow-pox virus. Ten fowls were submitted to a severe infection with cow-pox ; the feathers were plucked away from the neck and breast, and a large quantity of cow-pox virus vigorously rubbed into the bare patches. Each animal also received about $\frac{1}{4}$ gramme of the virus intravenously.

The comb was left untouched. A pronounced reaction developed in the animals, as manifested by a widespread oedema on the neck and breast and marked wasting. They recovered, however, in 12 days. Thirty days after the cow-pox infection these fowls together with 10 control fowls were infected by the application of fowl-pox material to the comb. A more or less distinct fowl-pox reaction developed in all 20 birds, and no difference was manifested in its intensity in the two lots.

A slight degree of general immunity might, however, have been set up which would not be sufficient to protect the birds against a massive fowl-pox infection.

An experiment was next performed in order to determine whether fowls that had recovered from fowl-pox infection and had therefore become immune against this disease also possessed immunity towards the cow-pox virus. Ten fowls were inoculated on two occasions with large doses of fowl-pox virus intramuscularly. As the result of the inoculation small vesicles were seen on the comb in a few birds. Twenty days later these ten birds, together with five controls were subjected to a vigorous application of cow-pox virus on to the comb. All the animals reacted and no difference could be observed between the birds infected beforehand with fowl-pox and the control birds.

Researches performed by Bassi (1896) and de Jong (1914–15) [this *Bulletin*, 1917, Vol. 5, No. 3, p. 200] have shown that the virus of equine contagious pustular stomatitis is identical with cow-pox virus (vaccinia). Van Heelsbergen's own researches would indicate that there is also a close connection between vaccinia and fowl-pox virus. It would thus be reasonable to assume that there is also a close relationship between the equine infection and fowl-pox. In 1879, Freidberger succeeded in transmitting a variolar infection to the fowl by means of stomatitis material from the horse.

Three horses were treated with fresh fowl-pox material. The mucous membrane of the upper lip was slightly rubbed beforehand with a small piece of fine sand-paper, which produced a slight hyperaemia. The fowl-pox material, which had been finely triturated and suspended in 50 per cent. glycerine, was then rubbed in by means of a small wad of cotton wool. Three control horses were treated in exactly the same manner with the exception that, instead of fowl-pox material, scabby material from fowls was applied. This scabby material was produced by rubbing the comb of a fowl with sand-paper; the comb became covered with a crust in from one to two days and after a few days it was scraped off, triturated in 50 per cent. glycerine and applied to the mucous membrane of the control horses. It was assumed that the same secondary bacterial flora would be present in this material as in the fowl-pox material, so that any difference in the reaction subsequently produced could be ascribed to the specific action of the fowl pox virus. The results were as follows :—

The control horses subsequently developed no lesions whatever beyond a slight hyperaemia due to the rubbing with the sand-paper.

In the case of the horses infected with fowl-pox a slight hyperaemia was seen on the day following the application of the material. After three to five days the follicles in the mucous membrane commenced to swell. Vesicles appeared, and the degree of congestion and sensitiveness of the membrane increased; salivation commenced; the contents

of the vesicles, which were at first clear, became turbid, and discharged; and, very soon a large number of inflammatory patches of various sizes appeared on the mucous membrane. Small ulcers coalesced to form large denuded patches and the whole picture showed a very close resemblance to contagious pustular stomatitis as this disease is seen in practice. After the ulcers had ceased discharging gradual healing took place and in 10 to 14 days the lesions had disappeared leaving only small scars. A small degree of fever (38·7 to 38·9° C) was observed in three horses. This experiment was subsequently repeated with four horses, which also gave positive results of the same kind.

The fowl-pox virus would thus appear to be capable of producing a pustular stomatitis in the horse showing a very great resemblance to stomatitis pustulosa contagiosa equi. Both viruses are filterable, and whilst the first is closely allied to cow-pox virus the latter is identical with it. On these grounds a close relationship thus seems to exist between the virus of fowl-pox and that of the equine disease.

MARXER (A.). **Die Beziehungen der Gastrophilus-Larven zur infektiösen Anämie.** [The Relationship between Gastrophilus Larvae and Equine Infectious Anaemia.]—*Ztschr. f. Immunitätsf. u. Experim. Therap.*, 1 Teil. Orig. 1920. Feb. 13. Vol. 29. No. 1–2. pp. 1–10. With 1 chart.

The work described in this paper again derives its inspiration from the studies published by the SEYDERHELMS (K. R. & R.) in 1914 upon the alleged capacity of extracts from the bodies of bots—the so-called oestrin—actually to produce equine infectious anaemia.

These authors' contentions have subsequently been refuted by the results obtained from the experiments of other workers,—Van Es and SCHALK, de KOCK, and Du TOIT.

At first the SEYDERHELMS considered the so-called oestrin to be specific for the horse. A considerable number of experiments were performed by Marxer, however, to demonstrate that the larvae or extracts from the larvae were also highly toxic when fed to the rabbit. Later, the SEYDERHELMS admitted the toxicity of the bot extracts for the rabbit. Rabbits fed with two larvae succumbed invariably and in the majority of cases one larva sufficed. The effects seem to be largely produced by the mechanical action of the larva inasmuch as a septicaemic condition was observed in most of the rabbits post-mortemed. Subcutaneous injection of rabbits with sublethal doses of extract produced an anaphylactic local reaction. The apparently specific infection which took place after the injection of some rabbits with the serum of other rabbits that had received lethal doses of oestrin was construed to be an anaphylactic phenomenon. Serum from a horse which had died following upon intravenous injections with bot extracts was injected into another horse in a dose of 200 c.c., with no result. Van Es and SCHALK, however, did succeed in transmitting an anaphylactic disturbance in this way.

The author concludes that Gastrophilus larvae have no causal connection with equine infectious anaemia, and that the larvae or their extracts in cases where they have been claimed to produce this disease in reality set up an anaphylactic reaction.

Moussu (G.). **La flèvre aphteuse.** [Foot and Mouth Disease.]—*Rec. Méd. Vét.*, 1920. Apr. 15—May 15. Vol. 96. No. 7 & 9. pp. 193–208.

At the time of writing France had just suffered from a foot-and-mouth disease epizootic of quite exceptional severity in respect of the losses occasioned, and the duration of the visitation. During the whole war period the disease had been allowed to run its course throughout the country, without much attention being directed to it; considerable damage was done but fortunately the intensity of the disease was not abnormal. Again, at the end of the war there were further movements of cattle for restocking the devastated regions, but all passed without causing undue anxiety until the autumn of 1919 and the winter of 1919–1920, when, for some inexplicable reason, foot-and-mouth disease suddenly resuscitated in a much more serious form than in former years. There were numerous cases of sudden death from the so-called apoplectic form. Cases ending fatally during the course of the disease or as the result of complications, and cases of sudden death during the convalescent period, were reported on all sides. In certain herds the percentage mortality was relatively very high whilst in others a short distance away the benign form evolved. At the end of the winter these severe forms became again attenuated.

This severe outbreak, which seems to have been only part of an exceptionally severe form raging through western and southern Europe at this time, is of much interest inasmuch as the observations made regarding its course would seem to upset a good many notions hitherto held concerning the epizootiology of the disease. It is hard to explain why, in the autumn of 1919 especially, the disease appeared in piggeries and in flocks of sheep, whereas in former years these same flocks had remained unaffected in spite of the fact that no greater precautions had been taken to ward it off; and, again why young pigs and lambs succumbed practically entirely almost everywhere whilst often the dams appeared so little affected that it was frequently difficult to decide upon a diagnosis. The losses among young animals were exceedingly high, and a 50 to 60 per cent. mortality was recorded among sucking lambs that had shown no manifest symptoms while their dams showed only some very slight lesions in the mouth and on the feet.

Another point worthy of note was the frequent reappearance, at short intervals, of the disease in the same herds and in the same establishments during this period. It is well known that an attack of the natural or experimental disease only confers a short-lived immunity, but it would be reasonable to suppose that when an outbreak had raged throughout nearly the whole country within a certain length of time (often several years) this country ought to be immune from further outbreaks for a few years. The author himself had previously observed animals, working oxen especially, affected once with the disease, kept for a long time on a farm, and then resist further infection in the event of a subsequent invasion with the disease a few years afterwards. Individual resistance undoubtedly plays a considerable part, and in the course of experiments performed during the 1900 outbreak, Moussu succeeded in transmitting the disease experimentally three times during the course of a year to the same animal; this

appeared exceptional at the time for the same result was not obtained with the other animals. It is certain, however, that during the late outbreak, especially in 1919, numerous farms were struck with the disease at least twice, at relatively short intervals. For example, in March 1919 foot-and-mouth disease appeared in a herd containing 30 working oxen of about 5–6 years old ; all became affected with the ordinary form of the disease and eventually recovered. Twenty-eight were kept on, and on the 10th April the farm was declared healthy. On the 1st November, i.e., less than seven months afterwards, the disease reappeared and all the animals were affected, with the exception of two of the oldest, which remained free although no special precaution had been taken to isolate them. The intensity of the second invasion was about equal to that of the first. According to HUYNEN the disease developed in the same manner during this period in Belgium.

During recent years Italy seems to have suffered greatly from the malignant forms of the disease, and some interesting experimental work has been carried out in that country. The investigations of COSCO and AGUZZI (1917) [this *Bulletin* 1917, Vol. 5, No. 3, p. 197] concerning the virulence of the blood in affected cattle are of special importance. The virulence had been looked upon as something very transitory in its appearance and difficult to demonstrate ; the Italian authors, however, claim to have proved that the disease manifests during its progress a succession of febrile crises, accompanied in the majority of cases by a succession of local eruptions, and that during the critical periods, and especially at the beginning of and during the rises in temperature, the blood is virulent, whilst it diminishes in activity at the times when the temperature subsides. Both red corpuscles and serum were said to be virulent and defibrinated blood retained its virulence for a period of 20 to 30 days when kept in the ice chest. A subcutaneous injection of serum or corpuscles transmitted the disease usually in three days, or maybe in up to 5 to 9 days ; by repeated subinoculations the virulence of the blood may be increased until it is possible to transmit the disease with 1 c.c. of blood subcutaneously, whilst, ordinarily, 10 c.c. are usually required. Intrajugular injection of a small quantity of virulent serum, $\frac{1}{4}$ c.c., constantly reproduces the disease, in the same manner as subcutaneous inoculation, whilst intrajugular injection of washed red corpuscles even in large doses (35 c.c.) does not reproduce the disease.

TERNI, of Milan [this *Bulletin*, 1916, Vol. 4, No. 4, p. 173], corroborated in the main the claims of the above authors, but believed that there was some sort of difference between *general immunity* (i.e., of the blood and viscera) and *local immunity* of the epithelial tissues (i.e., of the buccal mucous membrane, for example, and the skin at the extremities of the limbs.) The serum of animals recently recovered would seem to have a sort of protective action, not against the disease itself, but rather against the complications occurring in the severe forms ; virulent blood kept in the ice chest until it had lost its direct activity would appear to set up as solid an immunity as that resulting from the natural disease. The blood of young animals that had succumbed to the septicaemic form without visible lesions seemed to be as virulent as that of affected adult animals.

MORI, of Naples, advocated the employment of subcutaneous injections of hydrogen peroxide (10 grams per day per 100 kilos.

body-weight). Rapid recovery would appear to have been produced. Other authors, such as FRATELLI, SCLAVO, claim to have had good results following upon the administration of internal antiseptics. FINZI (1919) advised subcutaneous injection with the affected animal's own blood but admitted that this method could not be employed as a prophylactic. In 1919, however, this author declared that no real advance had been made in the treatment of the disease in Italy.

Before discussing the results of his own experiments Moussu asserts that no certain method or practical procedure has yet been devised that would provide a sure means of escape from the disease under ordinary conditions of breeding [in France]. One solution therefore remains, and that is to stave off the development of the disease, or limit its development to such slight morbid changes that would be almost without appreciable effects from an economical point of view upon the animals. Apart from good hygienic treatment there is no known specific curative treatment. With each fresh outbreak many remedies are boomed, in reality useless. In 1913 and 1914 Moussu experimented upon the possible preventive or curative effects of trypanblue, ichtargan, tartar emetic, solutions of salicylates, guaiacum, etc., given intravenously, but with negative results, whether the injections were practised before infection, immediately following upon infection, or during the febrile crises that are manifested prior to the development of eruptions. Indeed careful examination of animals thus treated at times would lead one to believe that some good effect often actually resulted following upon their use but immediately it was found that a product was not capable of arresting the regular development of the infection, even though this might be very mild in its subsequent manifestations, Moussu did not consider that it was worth while subjecting it to further investigation.

Specific immunisation has been attempted in various ways, without constant results (for example, by the use of virulent lymph highly diluted, heated, or mixed with various antiseptics; serum of animals recovered from the natural disease; serum of convalescent or recovered animals; glycerinated blood; mixtures of blood and of serum of recovered animals, etc.). The serum of animals that had been subjected to a tedious and difficult process of hyper-immunisation by means of repeated injections of virulent lymph does appear in fact to have some real protective property, but the passive immunity acquired is of such short duration that it is useless to think of adopting it in current practice. [See, however, following extract.—ED.]. The same might be said with regard to using a mixture of anti-serum and virus, a method which also has failed to give good results in practice.

Having in mind the recently acquired knowledge regarding the virulence of the blood in diseased animals and the time at which this virulence is most marked Moussu decided in 1918 to investigate whether there might not be some new method of combating foot-and-mouth disease analogous to the procedure now in use in dealing with rinderpest. In collaboration with LEDUC (E.), experiments were therefore carried out on the animals arriving at a public stock-yard (*station-magasin*); i.e., in the worst conditions that could be encountered in practice. Young vigorous animals recovered from the natural disease were submitted to massive inoculations with citrated virulent blood injected under the skin in doses first of three litres and then of six

litres. Each injection was always followed by febrile reactions of somewhat long duration, which might reach or even exceed 40° C in the case of the first injections but were slighter in the case of the later ones. Nevertheless the animals always retained a good appetite and never showed any other disturbing symptoms. Each cow thus absorbed over 20 litres of virulent blood injected subcutaneously; one calved normally afterwards without showing any signs of having been upset during the period of pregnancy. The serum of the animals thus prepared was collected eventually by the usual methods and utilised in different ways. Also, attempts at so-called haemo-therapy were made by using citrated blood taken from these animals. The experiments embraced over 300 head of cattle.

Curative effect.—Serum alone was employed the dose being 50 c.c., injected subcutaneously or intravenously into the subjects during the incubation period, when the temperature registered was above 38·5°C. The result was nil in all series of tests. It was perhaps not difficult to foresee this result, but it was useful to demonstrate it. The disease developed in the same manner as an ordinary attack, without any apparent lessening in its severity.

Preventive effect.—As it was impossible to undertake effective isolation in the conditions under which the experiments were carried out, the subjects after their arrival were always grouped in series compromising two lots, one of which was treated preventatively, and the other kept as a control for comparative observation. In the control lots submitted to natural infection—for the surrounding medium remained permanently infected on account of the arrival and departure of animals—the period of incubation varied fairly considerably in length, extending sometimes up to 20 days, but the average worked out at about 9 days. In control lots subjected to experimental infection by subcutaneous injection of virulent blood the disease developed quite appreciably more rapidly, and the average length of the incubation period was lowered to five days.

In the lots treated by the subcutaneous injection of serum (50 c.c.) the disease did not appear before the 17th day and certain animals did not show any symptoms before they left for the slaughter-house, and the average length of the period of incubation in the animals that were affected was 24 days.

When injections were given of citrated whole blood, in doses double the size of the serum doses (i.e., 100 c.c. each) it seemed as if the protective action was distinctly weaker than when serum was employed, as the average length of the incubation period in the case of affected subjects extended to 13 days only.

It would thus seem fairly well established that sero-therapy, or even haemo-therapy, when undertaken in the conditions indicated above, did prove effectual, producing a very marked retardatory effect upon the period of incubation. This was the whole extent of its efficacy. Consequently these observations only go to confirm what was already known with regard to the short duration of passive immunity, although the method of obtaining anti-serum or blood was different from the older method.

It has to be borne in mind, however, that the animals treated as above remained in a permanently and continuously infected environment, and that some of them did not show any signs of disease during

the observation period ; if the animals had been kept in the ordinary conditions on farms, the results would have appeared perhaps more favourable. For example, in a byre containing seven milch cows situated at a considerable distance from the stock-yard the disease appeared, and the circumstance was reported whilst there was as yet only one beast at the commencement of the eruptive stage. The remaining six animals immediately received 50 c.c. each of serum and not one of them contracted the disease during a period of two months' observation. The centre was isolated and there was therefore no recurrent reinfection of premises as was the case in the stockyard. It is but in such conditions that sero-therapy may prove of some utility.

However, inasmuch as the action of serum alone was certainly not of sufficient duration, and repeated injections could not possibly be generally practised during the course of an outbreak, it was resolved to ascertain what would be the effect of simultaneous or consecutive injections of serum and of virulent blood, the virulent blood being injected subcutaneously or intravenously.

In a series of tests comprising subcutaneous injection of anti-serum and 2 c.c. only of virulent blood subcutaneously (while the animals were retained continuously in an infected medium) the disease did not develop until after an average interval of 29 days. Again, in a final series, comprising the subcutaneous injection of anti-serum followed by an intravenous injection of virulent blood on the following day none of the animals showed visible symptoms of disease during an observation period extending up to 25 days, although there was a very marked temperature reaction (up to 3°C.) after the second day following upon the inoculation. The investigations terminated at this point on account of the closing down of the stockyard.

A noteworthy fact in connection with these last-mentioned results was the manifestation of an intense and prolonged febrile reaction, *without any eruption*, during the first few days following upon the intravenous injection of virulent blood. It was natural to enquire as to whether a pure and simple intravenous injection of virulent blood, performed as a sort of new method of aphtha-transmission (*aphtisation*), might not render some fresh information.

For example, intravenous injection of a small dose of highly diluted cow-pox virus produces a high degree of immunity in inoculated animals, though no pustules or blebs appear externally on the inoculated animals. A number of practitioners therefore at Moussu's request undertook to investigate this question. As soon as foot-and-mouth disease appeared on a farm, or at least when there was still only two or three animals affected, a certain quantity of blood was taken aseptically from an animal during the period when the local eruptions were appearing and the temperature was rising. The blood was citrated. Subsequently all the temperatures of the remaining animals were to be taken so as to operate only on animals showing no fever, i.e., least on those which were not on the eve of developing local eruptions ; otherwise, if this was no possible, all subjects that were not affected were to be inoculated. Each non-affected subject was then injected intravenously with 20 c.c. of virulent blood. Moussu quotes the results obtained from three practitioners operating on 12 establishments ; as an example of the results obtained the data concerning the first farm are reproduced.

Number of oxen 13, five of which showed developing or completely developed blebs, four showed a febrile reaction without visible lesions, and four were healthy. Blood was taken from one of the subjects recently attacked and showing an intense febrile reaction; 15 c.c. of the citrated blood were injected intravenously into all the other animals. The four healthy animals gave a temperature reaction which lasted three days but subsequently showed no local eruption. The four fevered animals afterwards developed some vesicles in the mouth but were fit for work eight days afterwards. The five which already showed vesicles at the time of injection ran through the ordinary form of the disease. Four milch cows left uninoculated developed an ordinary form of the disease, of moderate severity.

Moussu concludes, on examination of the results, that they point to the advisability of substituting this method of foot-and-mouth disease vaccination (*aphtisation*), namely, by means of intravenous injection of citrated virulent blood, for the old method of vaccination by the application of virulent material to the mouth. In the scene of an outbreak on any premises the object to be attained is to shorten as much as possible its duration on the establishment, and limit the losses to the least possible minimum. It would appear from the results obtained that intravenous injection enables animals at times to develop a febrile form of the disease without visible local eruptions, or at least with only moderate local lesions; inasmuch as these external lesions represent the principal source of trouble occasioned by the disease considerable progress would be marked if it were possible to suppress them. It would also appear that there are probably in reality forms of foot-and-mouth disease characterised simply by more or less prolonged attacks of fever and no characteristic local eruption, not only in young animals dying of the septicaemic form, but also in adults.

ROSENBUSCH (F.). **Ensayo con el Suero contra La Fiebre Aftosa (Loeffler). Su aplicación como preventivo en la Exposición de Setiembre de 1919. Su Exito. El suero tiene su aplicación merecida en las cabañas y tambos.** [Experiments on the Effects of Serum in Immunisation against Foot-and-Mouth Disease. Its Application as a Prophylactic in the (Palermo) Show of September 1919. Results obtained. The Serum merits Application on Steadings and Dairies.]—*Rev. Soc. Med. Veterinaria*, Buenos Aires. 1920. March 31. Vol. 5. No. 3. pp. 109–122.

It was decided by the Managing Committee of the *Sociedad Rural Argentina* to apply serum treatment according to Loeffler's method to the cattle exhibited at the September 1919 National Live-Stock Show. Difficulty was experienced in obtaining a sufficient quantity of virus in order to hyper-immunise healthy cattle; nevertheless a sufficiency was available so that ultimately a serum was manufactured the action of which could be studied under most varying conditions. The serum was prepared by injecting cattle intravenously with progressively increasing doses of virus filtered through a Berkefeld filter, the virus being obtained from the exudate and emulsions of triturated material from the blebs in the mouth or on the limbs of affected

cattle. Serum was collected aseptically from the hyper-immunised animals and then titrated by inoculating animals three weeks old, each with an increasing dose of serum (i.e., 2, 3, 4, and 5 c.c. per kilo. body-weight) and ·1 c.c. of virulent lymph. Control calves injected with ·1 c.c. of lymph alone died in two days with characteristic cardiac lesions; calves injected also with ·2 c.c. per kilo of serum died in four days, while those injected with ·3, ·4, and ·5 c.c. remained perfectly healthy.

Animals at the Show were injected in lots with 20 c.c., 40 c.c., and 60 c.c., and subsequently with 80 c.c. and 100 c.c. per animal, the size of the dose depending upon a number of circumstances. Some animals from some steadings were injected before they were entrained in order to avoid contamination during transportation. Careful examination revealed that the disease already existed on the ranches from which some of these animals were taken and had even penetrated into the steadings.

In the case of the lots injected on the steadings animals which received 20 c.c. each every 15 days remained perfectly healthy during the whole period of the Show (35 days); among these was one lot of 22 bulls known to have contracted the disease 2½ months previously in their steading, a time sufficiently long to lose all power of resistance against foot-and-mouth disease. The animals thus injected, however, were young light bulls that could be easily isolated from the neighbouring bulls in the same shed,—which were not injected and all became diseased.

One group of 15 bulls of various ages injected on the steading with 20 c.c. remained perfectly healthy; inasmuch as these quantities were recognised to be very low seven of these animals were reinjected on the fourth day of the Show with 100 c.c.; after twelve days one bull, the largest, became affected; it had been placed at the end of the group next to an affected bull. The infected animal was isolated and of the remainder only one became affected, 30 days after having been injected.

Another lot of seven animals was injected with 20 c.c. each, and three animals were reinjected on the fourth day of the Show with 100 c.c., and again each animal with 50 c.c. on the 15th day. All remained quite healthy during the Show, but they were separated from the neighbouring affected animals by empty boxes.

One lot was injected with 100 c.c. each, and remained healthy during the remaining 30 days of the Show.

A group of 11 large bulls, which were known not to have been affected for a year, were injected with 20 c.c. on the steading; five were injected on the seventh day of the Show with 100 c.c., as the 20 c.c. dose was not considered sufficient. These five remained completely healthy for a period of 13 days after injection whilst three cases of a benign form of the disease appeared in the remainder that were injected with 20 c.c. only. After a further injection to all the animals and the separation of the affected animals in the same shed these cases rapidly recovered and no fresh case appeared during the remaining 20 days of the Show. It would thus seem that a dose of 20 c.c. is an effective, but only partially effective, prophylactic dose and a dose of 100 c.c. gives absolute security when combined with separation of affected animals.

One lot of 16 animals was injected on its entry into Palermo with 20 c.c. each. On the third day seven of these were injected with 100 c.c. each. On the 14th day after injection four bulls became affected, and these had received 20 c.c. of serum only. These bulls were not isolated and the neighbouring bull, injected with 100 c.c. 15 days previously, contracted a mild form of the disease. These animals had been affected with the disease during the previous July.

Thirty-two bulls which had not been affected for a year were each injected with 20 c.c. on the steading, and 12 of them were reinjected on the third day of the Show with 100 c.c. each and these remained perfectly healthy. On the 14th day four bulls which had received only 20 c.c. developed symptoms. The animals were isolated by simply leaving an empty box between the affected and non-affected in the row of bulls, and the standings of the affected ones were disinfected. During the remaining 25 days of the Show no further case developed.

Animals from infected establishments, 155 in all, injected with from 20 to 100 c.c. of serum according to their temperature took a mild form of the disease and could be put up for auction. Doses of 20, 30, and 40 c.c. had been administered to Shorthorns, but inasmuch as the risk of infection in such a highly congested medium was considerable it was resolved to raise the doses to 60, 80, and 100 c.c.

For Dutch bulls a dose of 40 c.c. was found in general to be sufficient. For example, four animals belonging to one proprietor remained healthy and two more only acquired very small mild lesions in the mouth. These animals had been affected three months before entering the Show. Dutch bulls belonging to another owner received 100 c.c. each and remained healthy during the Show whereas others not injected became affected.

The same appears to apply to Aberdeen Angus cattle. Seven bulls belonging to one owner had received 100 c.c. and six others were not immunised; of the injected ones none became affected whilst all those not treated became affected, and three of them were taken to hospital for treatment; one of these developed acute symptoms and died as the result of secondary infection following upon the development of a vesicle at the base of the tongue and pharynx. These animals had not been affected for a year previously.

Seven animals of the same breed belonging to another owner had received 40 c.c.; in a few hours one bull developed symptoms and immediately 20 c.c. more were injected into the other animals, which were kept in the same place but separated from the affected one by an empty box; none of the injected ones developed the disease.

Besides these lots, others were injected during the full progress of the disease, and it was found that while doses of 20 c.c. and 40 c.c. did not prevent the development of the disease they undoubtedly caused it to progress more mildly.

Included in the bulls injected with 100 c c. were many that were surrounded by other animals not treated; many of them were in the incubation period at the time of treatment, and many were not injected till up to the 10th day after their entry into the Show on account of the fact that the owners did not give permission in time. The quantity of serum found necessary in order to check the progress of the disease varied from between 200 c.c. and 500 c.c. Further, Loeffler in 1909 had established in the course of numerous experiments that it was

absolutely indispensable to separate the affected animals from the immunised healthy ones. Immunised animals are capable of resisting small quantities of virus carried by intermediate agencies, but are not capable of avoiding infection after several days contact with affected animals that are constantly discharging the virus on their food.

In view of the formidable character of the contagion produced by the neighbouring affected animals towards the immunised animals it was possible to estimate the enormous advantage gained by the use of the serum when a comparison was made with what took place among the non injected ones. Out of a total of 500 non-injected bulls, 453 became affected with foot-and mouth disease, i.e., 90 per cent. The remaining 10 per cent. did not acquire the disease inasmuch as they had become affected during the month of August, that is to say, they had acquired an active immunity.

Out of a total of 605 bulls immunised with the serum, in various quantities, 272 became affected, i.e., 45 per cent. The animals receiving the smaller doses became affected to the highest degree. Those receiving 20 c.c. and 40 c.c. gave 65 per cent. of cases, and those injected with 60 c.c. to 100 c.c. constituted 35 per cent. of the cases.

A careful clinical examination of all animals exhibited for sale during the Show was made. This examination was commenced on the 15th September, and results obtained from the 15th up to the 19th pointed to the benign form taken by the disease in the majority of cases occurring in injected animals. In animals submitted for sale only 24 per cent. of those injected with serum were withheld for observation, and 60 per cent. of those non-injected were kept back on account of foot-and-mouth disease and its complications. The percentage among the injected ones might not have been so high if the environment had not been so highly contaminated and if account had been taken of animals that were injected during the incubation period. Nevertheless the total kept for observation (24 per cent.) corresponded with 64 per cent. of animals injected with small quantities of serum, and 36 per cent. injected with large quantities.

The results in this connection were very demonstrative in the case of one shed containing seven animals injected with 100 c.c. on arrival, and nine animals not injected. One of the non-injected ones died from complications of the disease. In the course of the veterinary examination seven out of the nine non-injected animals were kept back for observation whilst all the injected ones were declared healthy.

On account of the large size of the dose that was found to be necessary it became impossible to inject all the animals in the Show, and the Managing Committee therefore advised as an equitable and economical measure to submit only a reduced number of animals belonging to each proprietor to the treatment. It was not possible to hope for successful results by adopting such a course, having in mind the results of numerous observations made by LOEFFLER. This author had established that when an immunised beast was kept constantly alongside an infected animal it would sooner or later contract the disease, by the ingestion of material contaminated with the enormous quantities of virus voided by the diseased animal, due to the intense salivation set up in the disease. The Committee was therefore advised that a definitive proof of the value or otherwise of the serum was not admissible in this way and permission was obtained to inject all the

animals situated in a single shed (*galpón*). The animals in this shed consisted of cows, which suffer more from the effects of the disease than do bulls, and it was resolved to inject these animals provided consent was given by the owner. In spite of this limitation a very large amount of information was obtained regarding the isolation measures necessary, and upon with the value of the serum.

One hundred and five animals comprising cows and calves were injected, the cows with 100 c.c. and the calves with 30 c.c. of serum. These animals belonged to 31 owners; 17 cows belonging to eight owners were not injected as the owners' consent was not obtainable.

Out of the 17 cows not injected, 16 became affected, the one cow that remained refractory had suffered from the disease during the preceding month on the establishment it came from.

Out of the 105 animals injected 11 cows became affected; in seven of these the disease declared itself on the day following upon the injection; the majority (6) belonged to the same owner and were injected six days after entering the Show. In this group therefore, the injections were made during the period of incubation, and the dose of serum employed was not sufficient to cut short the disease. Three cows showed symptoms on the 10th, 13th, and 14th day respectively after injection, i.e., when the immunity conferred was declining; these cows were constantly exposed to infection from the non-immunised and affected cows in their immediate vicinity. The remaining cow calved on the 2nd day, and on the 11th day, i.e., the 11th day after the injection, it became affected.

The author states that the preventative value of the serum is successfully established by this experiment but adds that all animals ought to be injected on the day they are brought into the Show, and animals showing signs of the disease ought to be separated from injected animals so as to avoid constant and massive infection. Parturition appears to decrease considerably the resistance conferred by the serum and cows should be injected afresh after calving.

The value of the serum as a preventative and curative for bulls and calves on steadings was next tested. On three steadings the serum was injected into the breeding bulls at the commencement of an outbreak. The affected ones were injected with doses of 200 c.c. and 300 c.c., kept at pasture only, and separated from the other animals which had accompanied them in the same shed. These bulls developed a mild form of the disease. The healthy bulls were injected with 50 c.c. each, and did not acquire the disease.

The enormous losses among calves through foot-and-mouth disease when it attacks cows during parturition indicated a trial of the serum, and on one establishment in Cordoba where the disease was raging the calves were divided into lots for such an experiment. On the ranch lands the disease had been in existence for 20 days and no further mortality occurred either in the control or immunised calves, possibly because the outbreak was declining. In a place where 280 pure-bred Aberdeen Angus cattle were kept for cross-breeding purposes the disease had appeared during the height of the calving season. On the day prior to the injection three calves had died from the disease. 20 c.c. of serum were injected into all the calves (77) that had been born up to this time, and many of them showed lesions of the disease on the nostrils, mouth, and feet. Out of the injected calves one only died,—on

the day following upon the injection of the serum. The apparently healthy calves did not acquire the disease. More calves were, however, subsequently born, and the owner reported that during the next eight days out of 50 calves recently born and not injected, 22 died of foot-and-mouth disease, i.e., 44 per cent.

It would appear that small quantities of serum are sufficient to avert fatalities among calves and also that 50 c.c. injected into healthy, segregated bulls, is a sufficient quantity to stop the spread of the disease after its appearance in a shed. Such results can only be obtained if one intervenes rapidly with the serum injections and the diseased animals are isolated immediately.

The high cost of preparation of the serum and the short period of resistance conferred upon animals at present limits its application to selected conditions. Having in mind the results obtained in the course of his experiments the author discusses the measures that might be taken in order to frustrate the propagation of the disease in steadings (*cabañas*), dairies (*tambos*), open pastures or ranches (*hacienda general*), and in pig-breeding establishments

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MISCELLANEOUS.

NICOLAS (Ch.). **Contribution à l'étude de l'Ostéoporose chevaline dite "Big head," en Nouvelle-Calédonie.** [Equine Osteoporosis or Big-head in New Caledonia, Pacific Ocean (22.30°S, 165.30°E.)]—*Bull. Soc. Path. Exot.* 1920. Apr. 14. Vol. 13. No. 4. pp. 262–264.

In 1912 the author described some cases of osteoporosis among Australian and American horses at Houailou, New Caledonia. Further investigations were carried out in 1919. It was found that horse-owners at Niudiah and Niudivin had lost all their horses from the disease in the course of a few years. The condition was attributed by LANG, veterinary inspector at Noumea in 1912, to a lack of calcium in the soil and in the food. LEBOEUF, who was at the time in charge of the laboratory and examined some specimens, was of the opinion that the condition was due to a filterable virus. In the same year PECAUD ascertained the geographic distribution of the disease and in the absence of positive proof showed that the condition was most likely infectious in origin. In 1919 Van SACEGHEM reported some observations upon the disease in the Belgian Congo which seemed to prove that the affection was due to a lack of calcium in the drinking water [this *Bulletin*, 1919, Vol. 7, No. 3, p. 171]. The author describes two observations which do not appear to confirm this view. One horse appeared to contract the disease after visiting an infected stud and the other, a mare, became infected after having been served by an infected stallion.

DODD (Sydney). **St. John's Wort and its Action on Live Stock.**—*Jl. Comp. Path. & Ther.* 1920. June. Vol. 33. No. 2. pp. 105–114.

St. John's wort (*Hypericum perforatum*) is an erect, glabrous perennial, growing from one to four feet high, with a woody creeping

root: the rootlets extend a few feet from the plant and it is thus difficult to extirpate. It is a common weed in many countries and once it has established itself in a pasture it is difficult to eradicate as it is a very hardy plant. The author has studied its effect upon live stock in Australia, into which country it was probably introduced with fodder accompanying imported animals. At present it has become established in only a few districts, the largest being probably in Victoria.

The plant appears to have been used from very early times as a household remedy for various ills. Its effects were first studied by PAGOUÉ, in 1861, upon horses, by BAILLET, in 1862, upon sheep, by RICHET (G.) in 1913 and ROGERS (T. B.) in 1914. RICHET noted that grey horses with unpigmented skin were affected, and that the main symptom was pruritus, which varied in intensity according to the degree of sunlight to which the animals were exposed Quite a number of plants have been proved to possess this property of being able to sensitise unpigmented skin in a similar manner Dodd was the first to draw attention to the sensitising action of trefoil on live stock [see this *Bulletin*, 1916, Vol. 4, No. 2, p. 73] but its action is by no means so severe as that produced by St. John's wort.

Live stock are as a rule reluctant to eat this plant when mature and will only readily do so when there is little else to eat. When it is young, however, and before it has reached the flowering stage they appear to have less objection to it. The ill effects following upon the ingestion of the plant may be seen at any time of the year, but the plant is most potent in its flowering stage. When fully ripe it is so woody and bitter that even starving stock will hardly touch it. In the district in which its effects were particularly studied (an area of about 5,000 acres) the animals principally affected were sheep and cattle, but horses were occasionally attacked. Animals of any age are affected but young animals appear to suffer most intensely probably on account of the more tender condition of the skin and the smaller protection afforded by hair or wool.

In naturally occurring cases cattle show symptoms of trouble about two weeks after commencing to eat the plant. The earliest symptoms after experimental feeding were observed in 13 days but during this period, however, there were a number of dull days.

The symptoms in cattle are as follows: The animal shakes its head violently or even the whole body, scratches at its head and other parts with its hoofs, and rubs against posts, and at times races about the paddock as if attacked by bot flies; before long it commences to lick itself on the white haired places and soon the hair is removed leaving raw surfaces; the affected skin swells up, the nostrils and ears when not pigmented show very marked tumefaction and hyperaemia; scabs form over the excoriated surfaces, but are frequently removed again by licking. The pruritus is sometimes so intolerable that the animal appears to go mad, rushing into water holes, etc., where it tries to bury itself in the water or mud in an endeavour to obtain relief.

In sheep the symptoms are similar but affect the skin in general. Swelling is most pronounced on the ears and face and not infrequently the eyes themselves are affected. Sometimes the sheep after showing acute symptoms become affected with convulsions and die. The majority, however, after suffering intense pruritus, and loss of wool on the parts exposed to rubbing, becoming very poor in condition.

In horses, the only parts affected are those covered with white skin, generally on the hind legs in the region of the fetlocks.

In all animals showing marked signs of the trouble there appears to be more or less considerable cerebral disturbance mostly that of depression, occasionally the reverse, i.e., acute dementia. The main symptom, however, is pruritis, which is always present when the sun is shining.

The author gives a summary of feeding experiments with the plant upon sheep, the results of which confirmed the opinions arrived at by other workers as to the injurious effects produced by ingestion of the plant, particularly in its flowering stage. The daily amount fed to the sheep varied from 4½ lbs. to 4 ozs. during the late summer and early winter, and again in the spring. The most acute symptoms abated a few days after the cessation of feeding.

It is considered that the active principle in St. John's wort is a red fluorescent, photodynamic, soluble substance which is readily absorbed from the alimentary tract and deposited in the tissues, which when thus sensitised undergo a reaction on exposure to the sun's rays without protection. The reaction is probably of a chemical nature leading to the production of some substance which is irritant towards the vaso-motor nerves in the skin, with consequent hyperaemia, swelling, and exudation of plasma. The most noticeable damage to the skin, i.e., excoriation, etc., is brought about by the animal itself in the endeavour to assuage the intolerable itching. The cerebral symptoms are probably due to another active substance. The process may be likened in a general way to what occurs in a photographic plate.

MORGAN (E.). **Interesting Notes from Venezuela.**—*Vet. Jl.* 1920. June. Vol. 76. No. 6. pp. 218–222.

1. In Venezuela there is a peculiar skin disease of cattle, known as *arestin* in Spanish, affecting particularly full-grown cattle, and only the white or light coloured areas on their bodies. It never occurs in black cattle and in black and white cattle its effects are very striking at times inasmuch as the white areas are diseased and the black areas quite healthy. A black crusty formation appears along the back especially upon the loins and hind quarters, and eventually hard callosities are formed which sometimes appear as fairly large protuberances. When these are removed forcibly the exposed surface bleeds and forms a breeding place for maggots. The condition appears confined to the superficial layers of the skin and causes at times a great deal of pain and inconvenience to the animal. When the back is extensively involved the cattle show an appreciable loss of condition and the hide deteriorates in value to some extent.

2. In Venezuela and Colombia there is a mosquito, *Janthinosoma lutzi*, which is a carrier of the eggs of a fly called *Dermatobia cyaniventris* (a closely related fly *Dermatobia noxialis* has been described affecting cattle in the United States of America). The mosquito may deposit the eggs on the skin of cattle of all ages but more often they attack cattle with white hair and white skin. The larva (Spanish, *nuche*) is said to enter the skin; its adhesive portion is beset with hooklets and it has two strong oval hooks. The posterior end carries the stigmata. If left to themselves the larvae will remain in the skin for some time and finally escape to drop on the ground and form pupae

and imagos. In size and shape the larvae somewhat resemble those of *Hypoderma bovis*, but they are found chiefly behind the elbow, above the scrotum in the perineal region and sometimes in the neck region. Affected animals, if not treated, become extremely emaciated as the presence of the parasites often causes bleeding and a deep extensive lesion several inches wide often forms. The larvae appear to undergo very rapid growth. In Colombia there is a breed of cattle called "Ganado antioqueño," with black points, white hair and black skin. These appear to be immune to the attacks of Dermatobia larvae.

3. There is a belief among cattle breeders in Venezuela that even bats molest white stock more often than black. Perhaps this is due to the fact that owing to the nocturnal activities of the bat white animals are more visible than darker ones. Bats cause heavy losses in calves and foals by sucking their blood, and pigs and fowls are even attacked. Horses were noticed that were even too weak to walk on account of bats draining their blood every night. Young animals are unable to resist so well as the older ones and so they die off very soon from deficiency of blood.

The author describes an instance where bats had eaten off all the teats from sows and young pigs newly imported on to an establishment. Care has to be taken in buying breeding sows that none of the teats are missing. Bats bleed fowls by sucking through the aural orifice. Hens are found in the morning almost too weak to stand and in most cases they succumb. Usually no attempt is made on the part of the victims to repel these pests.

THEILER (Arnold), VILJOEN (P. R.), GREEN (H. H.), DU TOIT (P. J.) and MEIER (H.). **Cause and Prevention of Lamziekte.** *Union of South Africa, Dept. of Agric.*, 1920. Reprint No. 13. 25 pp. 1920. Pretoria: Govt. Ptg. and Sta. Office. [Reprinted from the *Journal of the Department of Agriculture*, 1920. June.]

In March 1919, a preliminary announcement was made that the cause of the South African cattle disease lamziekte had been discovered, and was a toxin derived from animal débris scattered about on the veld. [This *Bulletin* 1920. Vol. 8. No. 1. p. 77.] The purpose of the present article is to give a popular account of the facts so far ascertained, and suggest methods of coping with the disease. An account of the experiments is promised later. The etiological chain connecting up the disease with its source may be shown as composed of six links:

1. The toxin which poisons the animal.
2. The toxicogenic saprophytes which elaborate the toxin.
3. The carcase material out of which the toxin is manufactured.
4. The pica (allotriophagia, osteophagia) or depraved appetite which impels the animal to eat decomposing matter which it would otherwise shun.
5. The vegetation which produces the pica, the soil upon which that vegetation grows, and the climate of the district.
6. The susceptibility of the animal concerned, towards pica and towards the toxin.

The solution of the lamziekte problem therefore lies in the discovery of the best methods for breaking these several links, and from a practical point of view the most important link is the one that can be broken

most easily and most cheaply. The results of the authors' studies upon the various factors, or links, enumerated, are then discussed serially.

1. *Toxin.* The eating of carrion causes lamziekte, and any sort of carrion may serve as origin of the toxin. Rotten bones are probably the commonest source of toxin ingested by the cattle, though other carcase material may be more toxic than the bones, but cattle even with the most depraved appetite exhibit a particular craving for bones. When, however, pica is very marked, cattle will blindly attempt to satisfy it by ingesting all sorts of unusual things (allotriophagia).

Lamziekte was produced experimentally at Armoedsvlakte by drenching material obtained from the carcase of a horse, an ox, a sheep, a lamb, a goat, a kid, a steenbok, a mierkat, a fowl, and an ostrich. In the laboratory it was found quite easy to prepare carcase material consisting of the filtrate of cultures in minced liver,—obtained by passing the culture through a Berkefeld filter,—so toxic that ·0001 gram per kilogram body weight was fatal to cattle by subcutaneous injection. When given by the mouth it was considered that less than a gram might prove fatal for a beast weighing over 600 lbs. In one experiment 2½ grams of what was regarded as only moderately toxic material produced typical lamziekte in a beast weighing 700 lbs. in less than a week. So far, however, veld material has only been found which is capable of producing the disease in quantities of 1 oz. or more.

The quantity of bones in particular that was noticed to be ingested by animals showing a marked craving was extraordinarily high, varying from several ounces of obnoxious material to several pounds of less objectional stuff. The quantity required to produce the disease varied from a few ounces of stinking bones to a few pounds of slightly odorous ones. By the time bones are bleached and "sweet" the toxicity has almost entirely disappeared from them, and owing to the predilection exhibited by cattle for such bones, their ingestion tends to produce a paradoxical effect—they become a preventative of lamziekte instead of a cause. The length of time material remains toxic must vary considerably, but even bones can certainly remain toxic for over six months, and other materials probably longer.

The rapidity with which the disease manifests itself in an animal is broadly proportional to the quantity of toxin ingested. In experimental work an animal could be killed in from 17 hours to 10 days almost at will, by varying the size of the dose. Doses approaching the minimum lethal dose generally produced typical symptoms in about five days.

The toxin itself was thermo-labile: it was destroyed in a few minutes at 80° C, and at 75° C. by very prolonged heating. Sterilised bones, which were toxic before heating, could be used to cure pica. The closest analogy exists between the toxin and that of *B. botulinus*, but the behaviour of these two toxins upon the different animal species appeared to differ. Symptoms of experimental botulism in cattle were also distinctly different from those of lamziekte.

2. *Toxicogenic saprophytic bacteria.* Evidence was obtained by the usual laboratory methods of sub-cultivation that an organism or group of organisms was responsible for the toxin production. Moreover, the fact was suggested that the organisms were saprophytic rather than parasitic inasmuch as the certainty with which the disease

could be set up experimentally was directly proportional to the amount of material fed ; also, all experiments of earlier years upon the transmission of the disease on the assumption that the cause was a pathogenic organism proved negative, and the disease had been shown to be neither an infectious nor a contagious disease in the accepted sense of the terms. Other evidence was readily obtained by the injection and drenching of sterile filtered cultures ; these were toxic in large amount, but were non-infective in small amount ; material in which the toxin had been destroyed by a certain degree of heat (75°–80° C.), which did not destroy the spores, failed to produce lamziekte.

The toxin therefore produces the disease when separated from the bacteria, but the spores did not produce the disease when separated from the toxin. The living animal seems to be able to get rid of any bacteria with which it may happen to have become infected before the organisms have time to produce a toxin.

The organisms are anaerobic, sporulating bacteria ; although toxic material may be rendered non-toxic by boiling for a few minutes it may become toxic again after undestroyed spores have germinated : to sterilise toxic material completely it is necessary to heat it to about 130° C, or to boil on each of three successive days.

Hitherto the causal organism has not been isolated in pure culture. Impure toxic cultures, however, were easily obtained in which three different sporulating organisms were constantly present. Two of these were found chiefly in the cultures, viz., what would appear to be *B. putrificus* (a common soil anaerobe), and a racquet-shaped form of organism, but both of these when taken alone produced no toxin. Suspicion at present attaches to the third, a " drum-stick " form of organism. Comparison with two strains of *B. botulinus* excluded identity with any of the organisms.

The dose of toxin required to produce the disease experimentally in animals other than the ox, such as horses, sheep, goats, rabbits, and guinea-pigs, ostriches and poultry varied according to the species of animal.

Experiments were carried out in order to determine how a carcase became infected under natural conditions. A cow that had died on the veld from another disease was allowed to decompose with an intact skin ; putrefaction set in rapidly ; after 24 hours the spleen was removed and drenched to a tollie (bullock) ; this animal subsequently developed lamziekte and died.

In this case the spleen could not have become infected from the outside through the intact skin, and therefore the source of infection was in all probability the intestinal contents of the carcase immediately after death, thus indicating infection from the interior of the carcase.

Next, a full-time foetus from a cow which died on the eve of calving was at once removed from its mother and exposed to putrefaction on the veld. Material subsequently collected from it, and drenched to a tollie, rapidly produced lamziekte. The source of infection in this case would be the exterior.

Control experiments were carried out in fenced paddocks at Onderstepoort (an area in which cattle were not affected with pica or lamziekte). Postmortem-room carcases, with no history of lamziekte infection, were exposed on the local veld ; putrefaction set in as usual, but the carcase material proved non-toxic.

Certain animals were then drenched with toxic material sent from Armoedsvlakte : these contracted lamziekte and died. The carcases of these animals were now allowed to become putrid ; material from them on testing was then proved to be toxic, indicating infection of the dead body from the intestinal contents. The disease was readily maintained in the Onderstepoort paddock by carrying the infections through successive animals in this manner. In some of the animals, however, there was a tendency for the putrefaction to become non-toxic, suggesting that the local conditions were less favourable to toxin production than at Armoedsvlakte.

A non-infected carcase from the postmortem-room table, however, exposed in the vicinity of the toxic carcases of the experimental paddock produced a toxin, thus indicating that the infection could be transmitted over a somewhat considerable distance. A low degree of natural infection must, at all events, exist at Onderstepoort for a number of local carcases in the summer of 1919 developed a toxicity which could not be traced to foreign infection. However, there is no pica on the farm, and therefore no danger of the stock acquiring natural lamziekte.

Nothing is known with regard to the distribution of the causal organism throughout the country ; but, it is known that there are certain areas in which the organism is present but in which no lamziekte occurs because pica is absent ; and it is known that there are extensive areas in which pica occurs but from which the organism appears to be absent, and these areas are therefore free from lamziekte. The infection may be scattered by four common methods, viz., by blow-flies for short distances, and dust, birds, and moving animals, for long distances.

Blow-fly larvae are present in enormous numbers during the warmer parts of the year in a carcase undergoing decomposition and undoubtedly they assist in the rapid putrefaction. The larvae are toxic and although they are usually left untouched by animals suffering from pica they can produce the disease experimentally when drenched in sufficient amount. The pupae of these larvae are also toxic, and the causal organisms can be obtained in mixed culture either from the larvae or the pupae. However, in the winter months when blow-flies are absent the carcase may still develop toxicity and flies therefore by no means play an essential rôle in distributing the organisms. One must then assume infection from soil and dust, and the spores undoubtedly remain alive in soil for a considerable length of time. Winter decomposition of carcases does not, however, produce toxicity to anything like the same extent as does the rapid putrefaction of summer. In the winter of 1919 a considerable proportion of the carcases at Armoedsvlakte were found to be non-toxic, and of the carcases which were toxic a larger quantity of débris was required to produce the disease. Sometimes the carcases were found to be toxic in one part and non-toxic in another, indicating a localised, rather than a generalised infection with the toxicogenic saprophyte.

As indicating the influence of weather it was found that carcases were less toxic after heavy rains, particularly the carcases of which the skeletal part constituted the main mass left. The seasonal variation of toxicity is of importance in connection with the control of the disease, especially in regard to the seasonal variation of "osteophagia." Other causes of spread of the causal organism may be long

distance carriers such as birds and moving stock, and to a less extent dogs or jackals and wind laden with dust. It has to be admitted that the disease can spread and is steadily spreading to areas in which it was formerly unknown.

At present there are many areas in which pica is prevalent, but the disease unknown. In Natal for example all carcase material collected for experimental purposes has so far proved non-toxic, although gathered from farms on which craving was very pronounced. It has even been found that on two neighbouring farms kept in exactly the same conditions the mortality from the disease is high on one and negligible on the other. Once a carcase on the clean farm becomes infected, however, the process of multiplication of the toxicogenic saprophytes is believed to proceed very rapidly.

(3). *The material out of which the toxin is manufactured.* Any dead animal whatsoever, from whatsoever cause it dies, can serve as substrate or material out of which the toxin can be elaborated, the important constituent of the material being the protein or nitrogenous matter. It is probable that protein-rich vegetable material such as beans would also prove to be a good substrate, or in fact any dead vegetable matter provided the requisite degree of anaerobiosis were maintained. In the lamziekte areas dead animal matter is practically the only source of danger, and at certain times of the year such carrion can become so violently toxic that although a farm appears to be clean, and no carcases of dead animals can be found, yet the presence of the dead bodies of such animals as lizards, frogs, tortoises, barbels, hares, mierkats, birds, liguans, etc., may be responsible for a small outbreak. The greatest source of danger is from large animals dying on the veld, and therefore so long as the carcases of dead animals are carefully disposed of, the greatest danger will be removed, but so long as the carrion and even the smallest beast is there a small mortality from lamziekte must be expected at certain seasons on farms where pica is acute. This raw material from which the toxin is elaborated therefore represents the most important link in the etiological chain. The second most important one is the pica of the cattle.

(1). *Pica or Depraved Appetite.* Over large areas of South Africa, cattle show an abnormal craving, particularly for bones, but their persistence in devouring unusual things, however, only becomes very noticeable when they are congregated around human habitations. The general craving for rubbish is termed allotriophagia and the distinctive craving for bones is termed osteophagia. The pica of the lamziekte areas is probably due to one cause, viz., shortage of phosphorus, and it is therefore to be distinguished from other forms of pica. The connection between pica and lamziekte had often been noticed by farmers, and HUTCHEON went so far as to ascribe bone eating as a definite premonitory symptom and attributed the disease itself to a deficiency of lime and phosphate. BORTHWICK and SPREULL showed that the death rate from the disease could be materially reduced by supplying bone meal regularly at the rate of three or four tablespoonfuls a day. However, it was found that pica and lamziekte were not invariably associated. Further, inasmuch as no notice was taken of mild bone-chewing, lamziekte was averred to occur independently of pica.

The authors next describe a rough method for estimating the degree of craving in animals. " Sweet or bleached " and " distinctly rotten " bones were used, and the latter were sterilised beforehand in order to render them non-toxic. Two sets of troughs placed at separate ends of a large enclosure were filled, respectively, with these two sorts of test bones. The cattle to be tested were admitted first to the rotten bones; the number which picked and chewed these was noted, and regarded as " marked cravers." Those which refused to touch the rotten bones were then admitted to the sweet bones and the number which picked and chewed again noted. These were regarded as " mild cravers." The remainder which, however, would still usually consume a ration of sweet bone meal if offered to them were entered up as " non-cravers." All the cattle at Armoedsvlakte were tested once a week so that the effect of treatment on the seasonal variation of craving could be plotted in the form of curves showing the effect of the particular factor under investigation.

In May 1919, 40 per cent. of all grazing animals admitted to the test showed craving. There was then a gradual increase until the 5th August, when the maximum craving was reached, and 80 per cent. of all the cattle ate rotten bones. From that date onwards a gradual descent in the curve was noted, until the 27th October, by which time the craving had again fallen to 40 per cent. During this period the weather had continued dry, but as it grew warmer the spring vegetation began to appear, and this was regarded as responsible for the diminution in pica. During the ensuing fortnight rain fell, the young vegetation become almost luxuriant, and by the middle of November the craving had rapidly fallen to 6 per cent. of all the animals tested. The minimum craving was maintained during a fortnight of rainless weather, and then, as the young grass wilted, it rapidly returned, reaching a maximum of 82 per cent. within three weeks. For the next two months of drought it oscillated around these figures. In the middle of January 1920 the drought broke, the pasture rapidly recovered, and it was thought that the craving would again disappear. Notwithstanding the ample supply of good green grass, however, and the absence of wilting, the craving did not fall to the previous 6 per cent. but only to 50 per cent. As the age of the grass advanced towards maturity, the craving curve again rose, and by the end of March stood once more at 80 per cent. of all the cattle tested.

The degree of craving was found to be correlated with the phosphorus content of the growing vegetation and it can be generally explained, it is stated, upon a phosphorus-deficiency theory. During the period of initial high craving, hay cut from the grazing areas showed only ·08 per cent. phosphoric oxide. During the period of rapid growth after the rains the young grass showed ·56 per cent. of the oxide, i.e., seven times as much. During the period of lowest craving the phosphorus content remained fairly high, and as the craving rose again the percentage of phosphorus in the grass steadily fell. By 15th January it was down to ·18 per cent. phosphoric oxide. The poor response of the craving curve to the second rains is held to be explained by the fact that the ageing vegetation, though green and fairly luxuriant, remained low in phosphorus. The phosphorus curve and the pica curve are roughly the inverse of one another.

A liberal mixed ration rich in phosphorus was generally found to reduce the craving fairly quickly, though much seemed to depend upon the components of the mixture. A single ration of wheat bran containing 2 per cent. phosphoric oxide reduced craving in grazing animals in a few weeks, when fed at the rate of about 2 lb. per day. The quantity of bran required appeared to be roughly proportional to its phosphoric content. Lucerne hay, on the other hand, with a phosphoric oxide content of ·5 per cent., fed at the rate of 10 lb. per day for a period of six weeks, did not reduce craving in a batch of 10 grazing animals; this observation would suggest that it is not the actual proportion of phosphorus which is important, but also the balance of other constituents in the mineral matter of the plant. It would seem that craving can be removed by almost any phosphorus compound, provided it is assimilable and convertible into the form of phosphate.

Bone meal generally reduced pica almost to zero within a month when fed at the rate of about 4 oz. per head per day, although the quantity required varied during the season and was larger with some animals than with others. After the bone meal had been withdrawn the craving began to return and in the course of a few weeks came back to the percentage shown by the grazing controls. The winter craving required rather more bone material for reduction than did the summer craving—an observation which is correlated with the phosphorus content of the vegetation. With cows, heifers, and young oxen a craving removed by bone meal returned rather more rapidly after cessation of dosing than it did with working oxen. A very heavy ration of bone meal of about 1 lb. per day sometimes reduces the craving to zero in one or two weeks.

Calcium phosphate was found capable of taking the place of bone meal and this compound was quantitatively superior to bone meal if fed as precipitated calcium phosphate, but inferior if fed as ground mineral phosphate. Sodium phosphate could be used instead of calcium phosphate. Pure phosphoric acid was rapidly effective when given either in the drinking water or in the form of a paste made up with mealie meal; the quantity required per day corresponded roughly to the quantity of phosphorus in an effective daily ration of bran, and 16 to 26 grams (phosphoric oxide) per head reduced craving completely in a few weeks time—in all but the most persistent cases. The behaviour with pure phosphoric acid would indicate that the base in combination is unimportant, except in so far as it affects the absorption and utilisation of the compound itself. It is hoped that a cheap and easily digestible phosphate may be put on the South African market. Meanwhile, bone meal is recommended as the cheapest prophylactic on sale.

Compounds of elements necessary for plant nutrition, other than phosphorus, did not reduce pica when fed in excess, neither did plant ash as a whole. Substances such as sulphur, salt, iron sulphate, mineral acids, organic acids, arsenical compounds, kerol, Glauber salts, aromatic drugs, and other non-phosphatic compounds were tested and all failed to reduce craving. Strong acids such as hydrochloric and bases such as lime showed a tendency towards aggravating the craving. A higher ratio of lime to phosphorus in the mineral matter of a plant may possibly have an effect similar to a low absolute percentage of phosphorus.

That lack of phosphorus is the common factor in the production of osteophagia was illustrated by observations pointing to the fact that the vegetation of the lamziekte veld at Armoedsvlakte maintained pica, and could produce pica, when fed in stalls either as cut hay or as botanically independent grasses. Thus mixed hay, krulgrass (*Digitaria eriantha*), and besem grass (*Aristida uniplumis*) all reproduced pica in cattle in which craving had been previously removed by feeding on a balanced ration. A low phosphorus content was the recognisable common factor.

Another experiment was carried out at Onderstepoort, i.e., in an area free of lamziekte in an enclosure devoid of growing vegetation. A ration of wheat chaff (as coarse fodder), selected as low in phosphorus was tested (·16 per cent. phosphoric oxide), and Fanko, a flaked maize product (breakfast food) (containing only ·09 per cent. phosphoric oxide), was compounded so as to provide as low an absolute intake of phosphorus as possible. Ten "cravers" sent from Armoedsvlakte were placed on the balanced ration until the craving had ceased and were then put on to this phosphorus-low sythetic ration, derived wholly from products of a non-lamziekte area—the craving slowly returned.

It is therefore reasonable to attribute the osteophagia to a phosphorus deficiency. However, a significant observation was that the cattle increased in both weight and condition in the spring just as the craving became most acute. This would indicate that the veld is not so deficient as to induce real phosphorus starvation, but merely so deficient as to induce a cry for more. The individual variation in craving in different cattle is very great, and although liberal feeding with phosphorus-rich material will stop pica in most animals some retain their craving very persistently, indicating probably a tendency for craving to degenerate into habit. This has to be taken into consideration when bone meal is supplied to cattle as a palliative, as they might continue to eat it long after they would have ceased to become attracted towards dangerous rotten bones on the veld, and thus they would involve unnecessary expense.

Marked cravers ought therefore to be picked out by periodic testing according to the method described above. As craving is manifested the bone eaters should be separated from the others and fed on bone meal—3 or 4 ozs. per head per day; or, from ½ to 1 lb. if lamziekte is rife and it is necessary to reduce the craving quickly. Testing should be carried out as a matter of weekly or fortnightly routine during the most dangerous part of the year, i.e., during the period of droughts (in the spring and early summer). It has to be taken into account also that a bone meal ration improves the condition of the cattle of the lamziekte areas most markedly.

The best conditioned animals, it is stated, are also usually those which show the most craving, and as cattle fall off in condition they tend to lose craving. It is a common wail of the farmer that he loses his best beasts from lamziekte, while the poverty stricken "weeds" most frequently escape.

(5.) *Composition of Veld Vegetation and Soil.* This factor requires further elucidation. Among points noted in this connection were: Grass growing over burned veld and subsequently subjected to drought appeared to produce more marked craving in grazing cattle than did

grass from neighbouring unburnt veld. A low phosphorus content was characteristic of the soils of lamziekte areas, but a mere analysis of a particular soil is not considered sufficient to enable one to estimate the degree of pica which will characterise the area from which the soil is sampled. Manuring so as to increase the available phosphate of a soil is more likely to reflect itself in an increased luxuriance of growth than in the phosphorus content of the vegetation. Certain manurial experiments are in progress at Armoedsvlakte but the authors have in mind that any attempt to alleviate pica by this means would be far too costly for the wide lamziekte areas of cheap land.

(6). *Class of Animal and Susceptibility to the Disease.* Although many animals are susceptible to the lamziekte toxin, cattle only come into serious consideration as the others do not develop pica. The problem of immunisation is difficult, and active immunity towards the toxin is of very short duration, for cattle that have just recovered from one attack of lamziekte may succumb to another very shortly afterwards. Experiments, however, are in progress in order to ascertain whether an experimental immunity of longer duration can be established.

The situation is summed up by stating that it is only by removing material out of which the toxin is manufactured that the cause of the disease can be removed (link 3). Decreasing the susceptibility of the animal can only protect the particular animal immunised, and that can probably only be done for a very short time; it will not prevent toxin production. All efforts to clean the farm ought therefore to be made, and in the process the farmer can comfort himself with the reflection that he is not only stamping out lamziekte, but also diseases such as anthrax as well. The degree of success depends upon the energy of the farmer himself. At Armoedsvlakte, where the mortality from lamziekte was 30 per cent. in 1914, the mortality with a herd of 500 cattle was reduced to below 2 per cent. after the measures which are advocated in this paper had been adopted in 1919. The paper is concluded by the enumeration of a number of practical measures for the prevention of the disease.

MAGALHAES (O.). **Verruga dos Bovideos. (1. Nota previa.)** [Warts on Cattle.]—*Brazil Medico.* 1920. July 3. Vol. 34. No. 27. pp. 430–431.

In this preliminary note the author gives the results of some experiments carried out at the Instituto Oswaldo Cruz, Rio de Janeiro, on the etiology of the common warts of cattle. The animal which acted as a starting point for the observations was affected with a generalised papillomatous condition, the warts being especially numerous around the nostrils, lower parts of the limbs, and belly, and less numerous over the back. The warts were both fleshy and hard in consistence, pedunculated and sessile. The animal was in good general condition.

SCHINDELKA had previously noted that it was possible to transmit the warts by rubbing freshly collected material from them into the scarified skin of calves. Magalhaes found that material from the growths was infective 72 hours after it had been collected. A healthy steer inoculated intravenously with an emulsion made by triturating

the growths in normal saline solution became infected with the generalised condition. The triturated material was sown out on Sabouraud's maltose agar and kept at laboratory temperature, but remained sterile.

The filtrate obtained by passing the emulsion through a Berkefeld filter was inoculated intravenously into healthy steers, and in like manner a generalised form of the disease was set up. The filtrates were sown out on the more common laboratory media incubated at 37° C, and remained sterile. The inoculated animals showed a slight rise of temperature (40·5° to 40·7° C) after the inoculations. The general condition of the animals remained unchanged.

The period of incubation, that is, the interval elapsing between the time of injection and the first appearance of cutaneous lesions was 20 days in both cases, i.e., whether filtered or non-filtered products were used. It would thus appear that these growths are produced by a filterable virus.

REPORTS.

CEYLON. **Report of the Acting Government Veterinary Surgeon** [HOOLE (E. T.)] **for 1919.** 7 pp. F'cap. 1920. Colombo.

Rinderpest. This disease prevailed chiefly in the Western (1,140 cases, out of which 182 recovered), North Western (237), Sabaragamuwa (329), and Central (437) Provinces, the disease being introduced from India to Colombo (790 cases), and radiating from the outskirts of the municipality to the Western Province in a north-easterly direction along the main lines of traffic and from this Province to the three others in the same direction. The necessity is pointed out of paying very careful attention to the work of selecting and transporting cattle from India and to the quarantine arrangements in Colombo. The establishment of a quarantine camp in Colombo at a distance from the cattle mart is needed. The outbreak was dealt with by inoculation of contacts with anti-serum obtained from India and the usual police measures. It is contemplated in the near future to manufacture a serum in Ceylon with a view to carrying out the so-called simultaneous, or serum and virus, inoculation in infected herds.

Foot-and-Mouth Disease. This disease prevailed to a certain extent throughout the year, almost all the Provinces being infected with it, but not in a very virulent form. The total number of cases was 10,907, against 10,377 in 1918. Nearly all these cases occurred outside Colombo town; 285 died. Unlike rinderpest this disease appears to be enzootic in the Island, although fresh waves of infection are often introduced to Colombo and the Western Province by imported cattle from India.

Anthrax. In the various Provinces 259 cases were reported, of which 251 died. Certain low swampy pasture lands were suspected to be the breeding ground of this disease in the Matara District and on the cattle being removed from such lands the disease soon subsided.

Rabies. One hundred and sixty cases were examined at the Bacteriological Institute and 522 persons underwent treatment at the Pasteur Institute in Colombo.

Blackquarter. Fifteen cases were reported in the Province of Uva. The Island was free from "swine septicaemia" which gave considerable trouble during the preceding two years.

No case of surra occurred.

There was no outbreak of infectious disease among horses.

The total number of cattle and buffaloes for the whole Island is 1,597,617. There were imported 88 horses, 9,831 cattle, 12,133 sheep, and 56,024 goats. All these animals, except most of the horses, came from India.

A fresh impetus has been given to the improvement of cattle by the great interest taken in it by His Excellency the Governor and by the publication of the report of the Cattle Breeding Committee, which suggest the following as some of the means by which cattle breeding could be ameliorated in Ceylon: 1. By using good stud bulls. 2. By good feeding. 3. By taking care of the calves and young stock. 4. By selection of cows.

Details are appended with regard to quarantine arrangements, rabies statistics, and the working of the Government Dairy, the branch farm at Ambepussa, and the model farm.

EGYPT. **Ministry of Agriculture. Veterinary Service. Annual Reports for the Years 1916 & 1917.**—[LITTLEWOOD (W.) Director.] pp. 59 & pp. 43. 1920. Cairo: Govt. Press. [Price each P.T. 5.]

CONTAGIOUS DISEASES.

Cattle Plague (*Rinderpest*) *and Double Inoculation.* In 1916 18 deaths only from rinderpest were recorded, in two Provinces (Girga and Daqahliya), but in addition 104 cases were detected amongst cattle imported from the Soudan. In the preceding year (1915) 358 deaths were reported in the Interior of the country. In 1916 1,134 cattle were submitted to the double inoculation, with 3 deaths.

In 1917 the death rate from this disease showed a considerable increase, amounting to 4,794, in two Governates and 14 Provinces. This corresponded with a loss of 0·443 per cent. in 1917 as against 0·001 per cent. in 1916 of the total number of cattle in the interior. In addition there were 627 cases detected amongst cattle imported from the Soudan. 80,036 cattle were submitted to the double inoculation, with 6 deaths from rinderpest and 2 from other diseases. In November 1917 a Blood Institute was established in the vicinity of the Higher School of Agriculture, Giza, for the production of virulent blood from cattle imported from Cyprus. From December 7th 1917 to the end of the year 2,395 cattle were treated with rinderpest serum and virulent blood, with 6 deaths only. The remainder (77,641 cattle) had been subjected to a double inoculation with serum and (contamination with) infective nasal discharge.

Rabies. In 1916 there were 77 reported cases (72 dogs, 1 cat, 1 bull, 1 mare, and 3 donkeys) and in 1917 126 reported cases (111 dogs, 5 cats, 4 wolves, 1 buffalo, 1 horse, and 2 donkeys). In the Provinces and Governates 50,113 dogs were poisoned and 9 cats shot n 1916, and in 1917 45,463 dogs were poisoned.

Glanders. 50 cases in 1916, and 53 in 1917; 4,198 animals tested with mallein in 1916, and 2,934 in 1917.

Epizootic Lymphangitis. 16 in 1916, 19 in 1917.

Anthrax. 5 cases in sheep in 1916, 1 case in a sheep in 1917.

Sheep pox. 91 cases in 1916, 123 in 1917.

Foot and-Mouth Disease. 429 outbreaks and 10,635 cases in 1916, 8 outbreaks and 759 cases in 1917. In 1915 no cases of this disease were detected. A considerable number of the above cases were in animals imported from Cyprus, Port Said, and the Soudan.

Haemorrhagic Septicaemia. In 1916 81 cases in buffalo, cattle, and camels, as against 29 cases in 1915; in 1917 87 cases in cattle and buffaloes. There were no cases of haemorrhagic septicaemia in sheep in 1916; in 1917 46 cases were reported.

Mange. 508 cases in 1916, 452 in 1917.

Strangles. 24 cases in 1916, 90 in 1917.

Spirochaetosis in Fowls. 3 cases in 1916, 5 in 1917.

Trypanosomiasis. 60 cases in 1916, 148 cases in 1917.

Filariasis. 83 cases in 1916, as against 1 case only in 1915; 82 cases in 1917.

Piroplasmosis in Egyptian Animals. In 1916 224 cases detected, involving 161 in cattle, out of which 62 died, 49 sheep, and 14 horses, out of which 1 died. In 1917 120 cases involving 117 cattle, out of which 54 died or were slaughtered, and 2 sheep, both of which died or were slaughtered, and 1 horse which recovered.

Piroplasmosis in Soudanese Cattle and Sheep. 108 cases were detected in 1916 and 49 in 1917, in the Shellal, Luxor, Cairo, and Alexandria Quarantine Pens, and in the Cairo Abattoir.

Tuberculosis. 1,829 cases in 1916 and 3,737 in 1917.

Tetanus. 11 in 1916, 18 in 1917.

Ovine Caseous Lymphadenitis. 1 case in 1916 and 2 in 1917.

Coccidiosis. 25 cases in 1916 (24 in Soudanese sheep); 31 cases in 1917.

Contagious Bovine Pleuro-pneumonia. 187 cases detected in 1916 and 171 in 1917 all in cattle imported from the Soudan.

Stiff-sickness. 2 cases only in 1916, as against 215 in 1915; 3 in 1917.

Bursati. One case only in a horse in 1916, none in 1917.

Ringworm. Three cases in 1916, none in 1917.

Camel Pox. 44 cases in 1916, 31 in 1917.

Fowl Diphtheria. 40 cases in 1916, 29 in 1917.

Foot-and-Lip Disease. 15 cases in 1916, none in 1917.

Swine Erysipelas. 1 in 1916, none in 1917.

Malta Fever. 50 cases were detected in the Cairo Governate in 1917.

14,065 cattle and 74,961 sheep and goats were imported from the Soudan in 1916, a decrease of 6,216 cattle and 12,757 sheep and goats on the previous year. In 1917 the numbers imported were 26,062 and 133,502, respectively.

The numbers of animals that passed through the Shellal Quarantine Station showed a corresponding increase in 1917 as compared with 1916

The total number of animals imported from countries besides the Soudan in 1916 was 32,583, and in 1917 15,113.

536 animals were admitted into the Isolation Hospital for Contagious Diseases of Animals at Abbâsiya in 1917 and 350 in 1916.

Census returns showed that in 1916 there were in the country 492,650 cattle, 515,121 buffaloes, 34,403 horses, 17,226 mules, 526,181

donkeys, 94,991 camels, 8,580 pigs, 687,696 sheep, and 263,200 goats. The numbers in 1917 were 514,845 cattle, 565,738 buffaloes, 31,421 horses, 17,250 mules, 585,554 donkeys, 99,370 camels, 13,314 pigs, 807,506 sheep, and 308,336 goats. The Census figures for cattle and buffaloes given for preceding years indicate that there has been a striking diminution in head of cattle in the country. In 1903 the figures were 959,669 cattle and 718,023 buffaloes.

During 1916, 857,623 animals were slaughtered in the Public Abattoirs and in 1917, 713,591.

A large quantity of frozen meat was imported for consumption by the Troops in 1916 and besides this a considerable quantity by two British firms. In 1917 no frozen meat was imported by these two firms as all Australian frozen meat was purchased by the British Government.

There were 784 veterinary-legal cases in 1916 and 1,119 in 1917.

Veterinary Pathological Laboratory [Mason (F. E.) Veterinary Pathologist.]

Statistics are given in both Reports with regard to the morbid specimens examined at the Laboratory.

Systematic examination of Soudanese cattle arriving in Quarantine did not bring to light any disease not previously recorded in the Annual Reports.

One case of tuberculosis was detected in a bull from the White Nile Province. This was the first case observed in that locality. The other 8 cases of this disease recorded over a period of five years all emanated from Kordofan Province. Tuberculosis in Soudanese cattle is stated to be undoubtedly quite rare, and the same conclusion is drawn with regard to Soudanese camels from observations made.

Haemorrhagic Septicaemia of Camels. In the Report of the Camel Specialist to the Punjab Government 1915–1916 [this *Bulletin*, 1917. Vol. 5. No. 1. p. 71.] some experiments were recorded showing the insusceptibility of camels to bovine haemorrhagic septicaemia. In 1916 several outbreaks of a very fatal disease in camels, having all the characteristics of haemorrhagic septicaemia, were experienced in Egypt. The outbreaks occurred at the season during which this form of disease is most prevalent in other animals, that is, in the late summer and autumn after the infiltration water has risen in stagnant pools. The symptoms during life and the lesions found post-mortem were quite typical of a haemorrhagic septicaemia. Microscopic examination of blood, serous exudate from the throat swelling, and from lymphatic glands showed the presence in large numbers of bi-polar staining bacilli. On artificial media cultures were obtained of bacilli having all the characteristics of bacilli of the haemorrhagic septicaemia type. Guinea-pigs were found susceptible but rabbits were found to be resistant, in this respect differing from the causal organism of the bovine type of the disease. Further investigations are contemplated.

Haemorrhagic septicaemia was unusually prevalent during the latter part of 1916—an occurrence which has been noted in former years when the Nile rises to more than its usual height as it did during the year in question. Outbreaks of this disease were repeatedly traced to animals that had been watered from stagnant pools caused by the rise of infiltration water in low-lying land. From outbreaks originating in this way the infection was observed to spread to neighbouring

localities through the medium of carcases dead of the disease, skinned or otherwise, which were thrown into the canals, and infection was carried in the direction of the current. Many outbreaks were dealt with by the use of anti-haemorrhagic-septicaemia serum. The results, which are stated to have been encouraging, are dealt with in a special report by COOPER.

No outbreaks of ovine haemorrhagic septicaemia (contagious pneumo-enteritis of sheep) were reported during the year. The disease was first observed in the field in 1915 by a native inspector and his observations were confirmed in the Laboratory.

Trypanosomiasis and Tabanidae. For a number of years past Mason had noted that the tabanidae which carried trypanosomiasis, viz., *T. taeniola* and *T. ditaeniatus*, were usually very numerous during the fly season in the Suez Canal Zone, along the Ismailia Canal and in Eastern Sharqîya; this was what happened in 1915 and a considerable number of cases of trypanosomiasis occurred in Army camels in consequence. During 1916 the tabanids were fortunately not observed in the above localities although the number of camels had greatly increased. No cases of trypanosomiasis apparently occurred in the Canal Zone during the year.

For the same reason the Wadi Natrûn District remained free in 1916. On the other hand both the above species of tabanids were extremely numerous as usual in the Western Oases and a considerable number of cases of trypanosomiasis occurred in camels, but none was observed in any other animals.

Mortality in Camels caused by Ingestion of Sand. Early in April 1916 Mason investigated the cause of a high mortality in two Indian Camel Corps stationed on the sandy desert at Sâlhîya. The mortality started about 10 days after their arrival in the locality and a large number of deaths following upon a short illness had occurred. The symptoms were profuse sweating, diarrhoea, tympanites, colicky pains and depression, temperature usually normal; in some cases the animal was found dead without having shown any symptoms. Post-mortem examinat on showed slight patchy inflammation on the peritoneum; the rumen contained food mixed with sand and the so-called water pouches were filled with sand; reticulum usually intensely inflamed, with sand between the papillae; abomasum deeply inflamed, particularly at the cardiac extremity, where an accumulation of sand was found and the membrane had an excoriated appearance; patchy haemorrhagic inflammation of the intestines, particularly of those parts which normally contain solid or semi-solid ingesta, and the contents were frequently gritty; petechiae on the heart. Enquiry showed that these camels came from a region in India where there was no sand. In contrast with Egyptian or Soudanese camels which are accustomed to sand these camels were peculiarly careless in the way in which they picked up particles of forage material that had fallen on to the desert sand. If the mouths were examined between feeding times a pinch of sand could easily be collected from the tongue, and this cannot be done with Soudanese or Egyptian camels. The treatment recommended was (1) a full dose of oil to be given to each camel, (2) muzzles to be constantly worn when not feeding, (3) salt ration of 1½ oz. daily to be issued; grazing was allowed. The mortality, which had reached very high proportions, ceased in 14 days.

A number of experiments are described in which it is conclusively proved that the mortality was definitely attributable to the ingestion of sand and not to contagious disease.

Dysentery in Camels caused by Haemonchus longistipes. On several occasions during 1916 Mason observed in camels outbreaks of a disease in which the most prominent symptom was acute diarrhoea frequently followed by dysentery with fatal results. Post-mortem examination showed acute gastro-enteritis with the presence of nematode worms in large numbers in the abomasum. These were identified with the above species, which seems to have already been associated with a very fatal form of gastro-enteritis in Algeria. Good results were obtained by the use of anthelmintics when administered early in the course of the disease.

A nematode worm, identified as *Gongylonema scutatum* Muller, was discovered in the mucous membrane of the oesophagus of Egyptian cattle, sheep, goats, and camels. This is the first record of the occurrence of the parasite in Egypt and it appears to be entirely new in camel parasitology.

Filaria lachrymalis was discovered by the same native inspector in 30 per cent. of aged Egyptian cattle, and a considerably lower percentage in buffaloes.

In camels a filarial parasite, *Thelasia leesei*, was discovered inhabiting the conjunctival sac of camels; about 30 per cent. of old camels were found to be affected. When numerous these worms were found capable of producing conjunctivitis and even ulceration of the cornea.

In 1917, besides the usual routine laboratory examinations, 687 specimens were received from Army sources.

Investigations were made into a new disease in the camel named pseudo-antinomycosis (streptotrichosis) [this *Bulletin* 1917. Vol 7. No. 2. p. 33].

Also further observations were made on tuberculosis in camels [this *Bulletin* 1918. Vol. 6. No. 3. p. 181]. One congenital case of this disease was encountered.

Investigations were also made into a disease of camels known as *lahtia*. Some additional information was obtained, and the disease was reproduced experimentally, but all attempts to discover the causal agent failed.

Observations were made into a bone and joint disease which affects a high percentage of Somali camels imported into Egypt.

Experiments were conducted with a view to finding an inexpensive material for the prevention of parasitic mange in camels; arsenical dip proved ineffective.

Several outbreaks of haemorrhagic septicaemia in camels were observed. The observations reported in 1916 were confirmed.

Additional information was gained on the distribution of the trypanosome-bearing Tabanidae.

Further outbreaks of acute diarrhoea and dysentery in camels were found to be associated with the presence of *Haemonchus longistipes*.

The Reports close with an account of the working of the School of Veterinary Medicine [Rabagliati (D. S.), Director.]; notes by Cooper (H.), (in the 1916 Report) on "Septicaemia Haemorrhagica and Use of Serum," "Treatment of Camels for Mange in the

Districts," "Testing of Working Animals with Tuberculin," and "Spraying of Animals for the Killing of Ticks;" and, detailed statistical returns.

SOUTHERN RHODESIA. **Report of the Chief Veterinary Surgeon** [SINCLAIR (J. M.)] **for the year 1919 (with the report of the Veterinary Bacteriologist)** [BEVAN (Ll.E.W.)]. 17 pp. f'cap. 1920. Salisbury, Rhodesia: Govt. Ptr.

East Coast Fever (African Coast Fever). The number of fresh outbreaks during the year was eight and the mortality 798 head, as compared with five and 374, respectively, during the previous year. Eleven farms regarded as infected at the beginning of the year were released from quarantine, no case of the disease having occurred on any of them for at least 15 months. Of the eight fresh outbreaks five occurred in the Melsetter District and of these three were on farms, that had been previously infected but had remained free for several years. In the Gwelo District a fresh centre of infection accounted for a mortality of over 440 head within four months, and the disease was spread by the transport of oxen from this centre to a farm in the Mazoe District. A fresh outbreak also occurred in the Umtali District but no fresh outbreaks were brought to notice in the Victoria District, which contained a heavily infected centre in the previous year, the number of cattle involved being 6,747, and the mortality from East Coast fever 659, and from other causes 2,175.

The heavy mortality resulting from the outbreaks in the Gwelo and Mazoe Districts led to a good deal of criticism of dipping as a means of dealing with infected areas and of preventing infection on areas where it has been consistently practised for a number of years. It is to be noted, however, that in the Gwelo District the total mortality to the end of the year was 446 head out of a total of 658 in the originally affected centre; 214 deaths occurred during the first three weeks after the appearance of the disease, 437 occurred during the first four months, and yet only nine cases were observed during the succeeding four months. Thus the initial degree of infection was extremely heavy, and had it not been for dipping probably no more than 10 per cent. would have survived three months.

In the Mazoe District the unique observation was made of over 50 cattle actually suffering from the disease being deposited (by rail) at three farms where tick infestation was at a minimum as the result of regular dipping for a considerable period. The results were surprising and disappointing inasmuch as up to the end of the year 266 head out of a total of 615 contracted the disease and died or were destroyed. The mortality was heaviest among the working oxen and the suggestion was made that this was due to the rapid elimination of arsenic from the skin as the result of the constant daily exertions. However, the main cause of the high death rate was actually the heavy tick infestation of the imported cattle on arrival, and the animals were apparently not dipped until a week afterwards.

It was also alleged that the method of dipping was at fault inasmuch as the ears and tails of all animals were not dressed. It had become a practice not to insist upon dressing of these parts on farms where dipping had been regularly practised.

Published records for the last ten years on the other hand show that the mortality rate from the disease, and the period required to eradicate infection depend entirely on the degree of infection in existence at the outset, no matter what methods of dipping, hand-dressing, etc., may be practised. Where there has been a heavy mortality with the dissemination of large numbers of infected ticks in consequence, the subsequent mortality is heavy and persists up to twelve months from the date at which short interval dipping was begun. Where the disease is discovered early, say after one or two cases have appeared, and short interval dipping is immediately adopted, the subsequent mortality is negligible.

In order to provide for the more effective execution of the provisions of the Cattle Cleansing Ordinance 1918 in areas where it is operative, cattle inspectors were relieved of the work of issuing cattle permits, and an increased transport allowance was granted for the larger inspectorates, the object being to enable these officials to devote practically all their time to inspection of stock. But, it is admitted that there were many drawbacks attendant upon this system and that in reality the solution of East Coast fever and various other difficulties rests largely with stock owners and not on laws and regulations. It is urged that when a stock owner cannot assign a definite cause for any illness or mortality he could render real assistance to the Department by forwarding blood smears and a short description of symptoms and even post-mortem appearances.

During the year 229 dipping tanks were constructed, bringing the total number up to 1,583. Many tanks, however, are still required before the dipping of all cattle in the areas under the Ordinance can be carried out.

Black-quarter (Quarter-evil). This disease continued to spread throughout the year and appeared in the following districts in which its existence had not previously been recorded; viz., Salisbury, Somagundi, Mazoe, Mrewa, Hartley, Marandellas and Charter, and (one case) Melsetter. Upwards of 225,000 doses of vaccine of various kinds were distributed during the year. The results of inoculation on the whole, while not unsatisfactory, were by no means uniform and it could not be said that any one preparation was superior to the others. In Matabeleland the mortality reported was 933 head of cattle and in Victoria 145 head. Experience in the former of these districts seemed to point to the mortality being much heavier during the year in which the disease first makes its appearance, than in subsequent years. In 1916, the disease presented more the appearance of a contagious than a sporadic disease, and even old animals succumbed to it in a small percentage of cases, and animals died from the disease all the year round. Clinical experience tends to suggest that the disease in the first infected districts is becoming seasonal as it is in other countries, and it appears to occur to the greatest extent after the rains have fallen, i.e., in December and January after the first portion of the rainy season, and in June to September after the second and heavier portion of the rainfall.

Anaplosmasis and piroplasmosis in cattle. This disease caused considerable mortality chiefly among pure-bred and grade animals and both diseases were generally more prevalent than during the previous year [see this *Bulletin*, 1920. Vol. 8. No. 2. p. 167].

Anthrax. Four outbreaks occurred during the year the most serious being in the Shamva section of the Mazoe District where 102 head of cattle died on 18 farms. All the cattle involved in these outbreaks were vaccinated, with most satisfactory results.

Contagious Abortion in Cattle. Since this disease was first discovered by the Veterinary Bacteriologist in 1915 observations have shown that it is widespread throughout the Territory and in most cases its specific nature was not suspected by stock owners, either European or native. It is held that the measures carried out in dealing with an infected herd, viz., distribution (disposal) of all aborted foetuses, a course of inoculation with massive doses of a devitalised vaccine prepared at the Veterinary Laboratory, dipping, the removal of bulls from the herd for a period of from four to six months, and where possible the segregation of known aborters, appear to have given satisfactory results, judging from the fact that in many instances the calf crop during the following season was practically normal.

Tuberculosis. The only case reported in the Territory during the year was that of an aged Sussex bull originally imported from England. At the Johannesburg Municipal Abbattoirs eight cases were detected at post mortem inspection of Rhodesian slaughtered cattle.

Trypanosomiasis. A number of fatal cases occurred amongst cattle in the Melsetter, Hartley, and Wankie Districts.

Myiasis in Cattle. This condition was first observed in the Salisbury and Mazoe Districts in 1918, since when it has been reported in practically every district in the Territory. It is most prevalent during the summer months and in districts with a heavy rainfall but cases are not infrequently seen during winter [see this *Bulletin*, 1919, Vol. 7, No. 1, p. 20—for JACK's description of the larva]. The larva or maggot is commonly termed "screw-worm" on account of a fancied resemblance it bears to a screw. The destruction of the maggots is a comparatively simple matter provided the animal is cast and the wound or cavity thoroughly dressed. Volatile agents which penetrate thoroughly into the burrowings are best and of these carbon bisulphide has given the most satisfactory results. To prevent further infestation, the wounds and surrounding skin should be dressed with an emulsion of Stockholm tar containing a small quantity of iodoform in solution, and finally the application of dry wood ashes or lime. To reduce the fly crop as much as possible every maggot should be destroyed and all carcases buried deeply or burned.

Export of Cattle. The export of cattle to Union markets was continued during the year. In August the Union Government authorised the exportation of breeding cattle to the Northern Transvaal for restocking purposes.

Horse sickness. The total number of deaths reported during the war was 89, mostly horses, but this does not represent the total mortality as many cases were undoubtedly not reported to the Department.

No case of glanders occurred, and no reactions to the mallein test, which was applied to all imported horses, mules, and donkeys.

An outbreak of epizootic lymphangitis occurred amongst the mules at the Citrus Estate, Mazoe, in January, five animals being affected. These were destroyed, and precautions taken to prevent the further spread of infection. It is impossible to explain the reappearance of this disease after over ten years freedom from it.

A schedule is attached showing the numbers of stock exported and imported.

Report of the Veterinary Bacteriologist. 1,400 smears and bacteriological specimens were examined in the course of routine work in the Laboratory. East Coast fever was detected in 184 preparations, anthrax in 33, black-quarter in 81, trypanosomiasis in 18, and epizootic lymphangitis in one.

Infectious abortion of cattle was detected by the application of the agglutination test in 30 out of 200 specimens of blood collected by the pipette method devised by Bevan. 4,700 massive doses of vaccine were issued and most favourable reports were received from the users of the vaccine. It is thought possible that the remarkable cessation of cases was largely due to the removal of the bull from the herd for a lengthy period, the well-defined calving and service season which rendered such a procedure feasible, the drying up of grasses and water pools during the winter months, the burning of the veldt and the systematic dipping of cattle in arsenic-containing solutions.

Horse-sickness. Some experiments were carried out, but it is not claimed that any material progress in the existing knowledge regarding this costly disease of equines has been achieved. The application of the virus-vaccine method of inoculation gave fairly satisfactory results but the many problems associated with the cause, transmission, and cure of the disease still remain to be solved. During the years 1912–1919 220 police horses had been treated; of these 33 died under treatment. The number of inoculated horses exposed to natural infection was 472 and of these 19 died from the disease and 10 from other causes. Twenty-nine horses out of 35 exposed survived four seasons, 106 out of 133 survived three, 129 out of 156 survived two, and 173 out of 187 survived one season. It is fully recognised that the present system of inoculation, while successful as far as it goes, is by no means perfect and a considerable amount of investigation remains to be done in order to evolve a more suitable means of protection. The particular value of the inoculation lies in the proved resistance to horse-sickness of treated animals on exposure to natural infection. As early as 1908 it was realised that foals possess some slightly greater resistance to infection than older animals, although this resistance was not sufficient to protect them against a full strength virus. In 1916 practical use was made of this observation when vaccine was supplied to owners for the inoculation of yearling colts, with results which are stated to have proved very satisfactory during the following horse-sickness season. The issue was suspended in December, i.e., at the commencement of the season of natural infection. Reports concerning 135 cases show that death only occurred in seven horses.

Ten out of 13 horses inoculated in 1919 reacted but six horses that had been inoculated during the previous year did not react to a second injection. A filly four months old, whose dam was known to have suffered from horse-sickness and recovered, yielded a well-marked thermal reaction and was visibly distressed for several days.

"*Sweating sickness*" is the name given to a mysterious disease of cattle, principally calves and young stock. During the early months of the year the condition assumed rather serious proportions; during the latter part of the year numerous cases were reported from all

parts of Mashonaland and the mortality was sometimes as high as 50 per cent. of infected animals. The symptoms were high fever, congestion of the mucous membranes, mucoid discharges from the eyes, nostrils and external orifices and a ropy saliva from the mouth. The mucous membrane of the lips, tongue, and mouth was inflamed and frequently ulcerated. There were sometimes signs of abdominal pain; there was constipation and the animal urinated with difficulty. In the majority of cases the animal's body was bathed in perspiration, hence the name " sweating-sickness " and this condition often persisted until death ; in cases that recovered it gave place to a painful hardness of the skin which became corrugated and cracked, often with an accumulation of waxy material and desquamated skin in the folds. In many cases on recovery the hair fell out leaving the animal bald; frequently, large patches of skin were sloughed leaving a slowly healing wound. Post-mortem, there were no specific lesions ; the blood was dark and tarry, the mucous membranes dirty red and the organs congested or blood stained. The serous cavities sometimes contained a quantity of blood stained fluid. Microscopic examination of the blood revealed no specific organism and inoculation of blood from sick to healthy animals failed to transmit the disease. A disease which was very prevalent throughout Matabeleland at the same time of the year presented many of the above symptoms, with ulceration of the mucous membrane of the mouth and swelling and cracking of the skin above the feet as a frequent sequel. The outbreaks seemed to have a fairly localized distribution. They were reported to occur after a period of dry weather during the hot rainy spells in January and February.

Myiasis or " Screw-worm." This disease of cattle was very prevalent throughout the country during the year causing heavy losses to stock owners. The fly belongs to the genus *Pycnosoma*, closely resembling *P. albicans*, and deposits its eggs at or over any abrasion of the animal's surface and the larvae hatching from these eggs bore into the injured tissues by means of the spines surrounding their pigmented bodies. It is believed that the puncture caused by the " striped-legged tick," *Hyalomma aegyptium*, was often the primary injury. The tick is one of the most difficult to eradicate by dipping and is still comparatively numerous on many of the farms where dipping has been practised for some time, but where the " screw-worm " disease has been more prevalent. The larvae after burrowing through the skin into the tissues, form large cavities which for some time are covered by an apparently sound integument. It is only when a large area of skin sloughs, leaving an enormous cavity filled with " maggots," pus, and putrid material, that the existence of the injury is realised. Owing to the long channels bored by the larvae it is very difficult to cleanse the wound properly. Such agents as carbon-bisulphide, petrol, paraffin, tar, etc. have been used as remedies, their principal value lying in their power to destroy the maggots.

Distomiasis. Within recent years the infection of cattle and sheep with fluke has become alarmingly frequent. The treatment of cattle with extract of male fern has proved beneficial but the cost of this drug is somewhat prohibitive. The large percentage of natural recoveries is stated to be a remarkable feature of the disease as it occurs in Southern Rhodesia.

East Coast Fever. No research work was done on this disease but attention is drawn to certain circumstances (enumerated above) in connection with recent outbreaks which suggest that the regular dipping of infected cattle every three days in standard solutions of arsenic does lead to suppression of the disease.

Blackquarter. Several preparations of so-called germ-free filtrates were used for vaccinating cattle. The first experiments were made with sheep to test the efficacy of these preparations and it would appear that one of the proprietary "filtrates" which had been extensively used failed to protect sheep, but a second test showed that it was more successful when given in doses larger than those recommended by the manufacturers. Another proprietary germ-free material is stated to have proved more successful.

Bovine Redwater and Gall-Sickness. During the early part of the year a large number of cattle died from the diseases especially upon farms where systematic dipping had been practised for some years. Animals born and running on such farms had grown up free from infection and had thus become susceptible to natural infection; also the cattle of these farms had been graded up by the introduction of imported stock. In order to protect cattle about 400 doses of virus-vaccine of low virulence were issued. Out of 25 clean animals thus inoculated 16 gave a redwater reaction, but all except one yielded a well marked anaplasmosis reaction.

Some details are added concerning the inoculation camp and the inadequacy of the present laboratory buildings and equipments to deal with the work demanded of the Department.

International Congress of Comparative Pathology.

We have received from Professor G. H. F. Nuttall, F.R.S., a leaflet giving information about the Second International Congress of Comparative Pathology, to be held in Rome, in April, 1921. Professor Nuttall has received a letter from the President of the Organisation Committee, Professor E. Perroncito, and the General Secretary, Professor Mario Levi Della Vida, in which he is asked to form, in Great Britain, a National Committee, and to furnish the name of experts who would draw up reports on the subjects named below, as well as on other subjects of general interest.

All the titles together with abstracts of the contents should reach the General Secretary, by Dec. 15th 1920.

Correspondence should be addressed to the Secretaire Général du Comité d'Organisation, 58, Via Palermo, Rome.

Professor Nuttall adds that he is requested to send the names of those persons throughout the British Empire who may desire to aid in the work of the Congress. His address is Longfield, Madingley Road, Cambridge. The subscription has been fixed at 40 lira.

The Provisional Programme (June 1920) is as follows:—

(a) Influenza de l'homme et des animaux.—(b) Fièvre aphteuse: nouvelles recherches.—(c) Cancer et sarcome. Les données actuelles sur la question du cancer.—(d) Rage et vaccination Pasteurienne: résultats.—(e) Peste bovine ou des ruminants: nouvelles recherches.—(f) Peste des poules et les dernières recherches sur les maladies des poules.—(g) Peste des abeilles.—(h) Cycle évolutif du *Dibothriocephalus latus* de l'homme et des animaux.—(i) Flasserie des vers-à-soie. (j) Cycle évolutif des ascarides.—(k) Cycle évolutif des ankylostomes.—(l) Les piroplasmoses.—(m) Questions relatives aux acares, et la gale de l'homme et des animaux.—(n) La régénération des nerfs dans la pathologie expérimentals, dans les maladies nerveuses et dans les lésions de guerre.—(o) Symbiose et parasitisme chez les végétaux.—(p) Ténacité de vie des parasites animaux et végétaux.—(q) *Diaspis pentagona* et *Prospartella Berlesei*, et insecticides.—(r) Questions relatives au *Phylloxera*."